

REPORT
OF
TOPOGRAPHIC AND GEOLOGIC
SURVEY COMMISSION
OF
PENNSYLVANIA.
1908-1910

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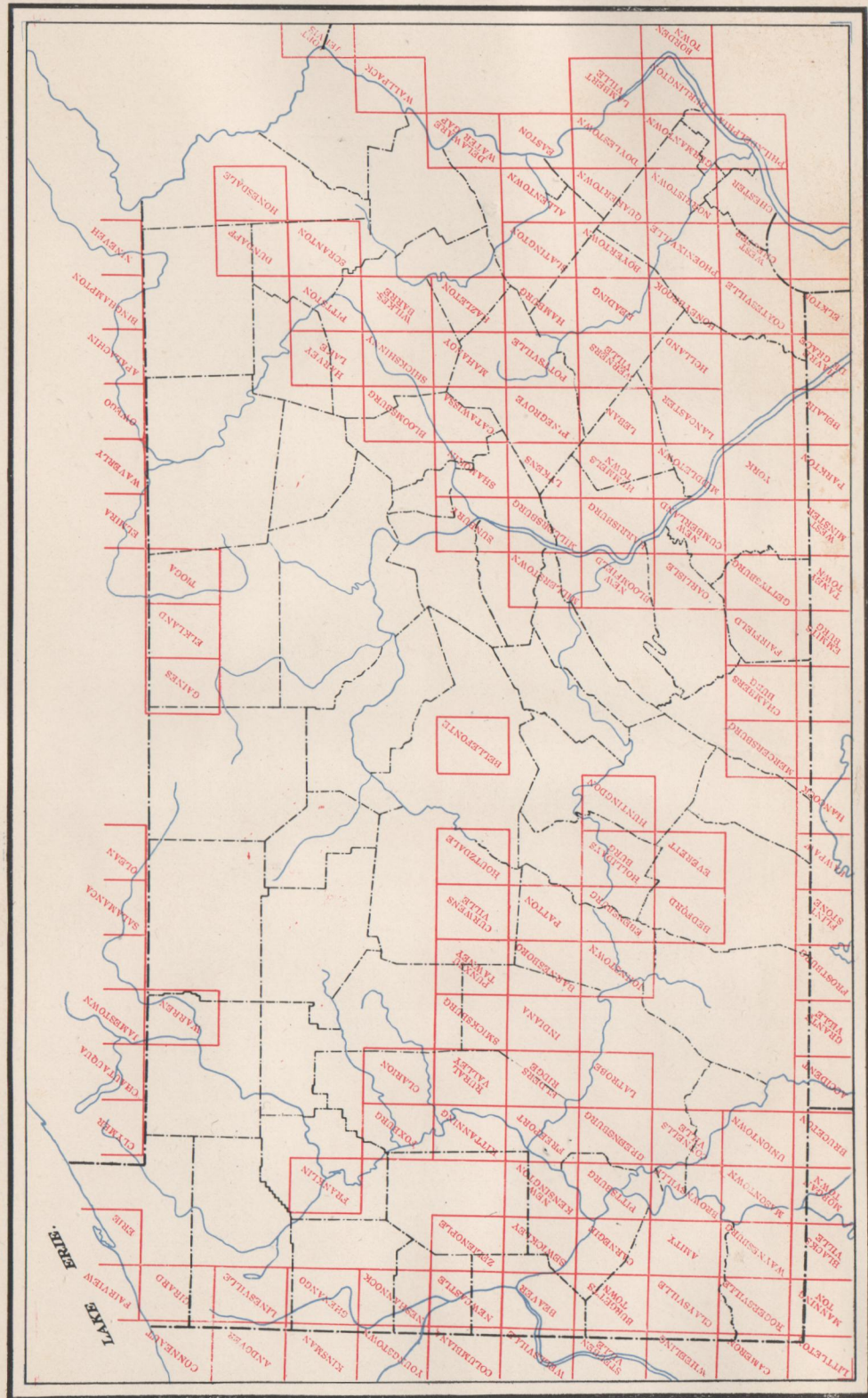
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Report



Commonwealth of Pennsylvania.

Topographic and Geologic Survey

[Report]



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LETTER OF TRANSMITTAL.

To His Excellency Edwin S. Stuart, Governor of Pennsylvania:

Sir: The undersigned, Commissioners of the Topographic and Geologic Survey of Pennsylvania, have the honor to submit the following report of the work accomplished during the years 1908-1909 and 1909-1910.

Very respectfully,

GEORGE W. McNEES,
ANDREW S. McCREATH,
EDWARD V. d'INVILLIERS.

Harrisburg, Pa., August 1st, 1910.



TOPOGRAPHIC AND GEOLOGICAL SURVEY OF PENNSYLVANIA.

INTRODUCTORY.

The work done under the direction of this Commission was originally started under the provisions of an Act of Assembly approved April 28, 1899. Under the provisions of that Act the Commission then appointed entered into a contract with the United States Geological Survey for the preparation of a topographic map of Pennsylvania, on the scale of 1:62,500, with contours for each 20 feet of elevation, and included in this contract were arrangements for geological work on a co-operative basis. (See Appendix A.)

Results of the work done under the above mentioned agreement (and supplemental agreements continuing the same in force), will be found in three reports, one covering the work for the period ending June 30, 1901, the second covering the work to June 1, 1906, and the third covering the work to the close of the year June 1st, 1908.

In addition to these reports some of the results of the geological work have appeared in publications of the United States Geological Survey and all completed maps have been issued by that organization. No provision whatever was made by the Act of 1899 for the compilation and publication of any of the results of the work by, or on behalf of, the State.

The results of the co-operative topographic work thus far completed are graphically represented on the Index Map, forming the frontispiece of this report, where is shown the condition of the work in the several portions of the State.

During the year 1908-1909 all the work was under the provisions of the contract made in pursuance of the Act of Assembly above mentioned, but, the fact that the United States Geological Survey was at times unable to co-operate to the extent desired, the demand for publication by the people of the State in a more popular form than the Folio of the United States Survey, coupled with the necessity for more detailed and exact work; the constant transfer by the National Survey of men to other parts of the country and the consequent employment of those unacquainted with Pennsylvania conditions; and the fact that the United States Survey is giving an

ever increasing attention and consequent percentage of its appropriations to work in the West, with corresponding neglect of the increasing demands of the East, leaving the work here to State Surveys, caused the Commission to ask the last Legislature for a change in the laws governing the work, by which money might be expended independently of the United States Survey.

This Act was duly passed (Appendix A) and the work of 1909-1910 has been under the authority of that law.

TOPOGRAPHIC WORK.

The methods of location of triangulation stations, of the Primary traverse and of the level lines were briefly described in former reports. There have been no changes in methods, aside from the general increase in accuracy constantly demanded by the Topographic branch of the United State Geological Survey.

Pennsylvania has an estimated area of 42,215 square miles, and for the purposes of the topographic map it is divided into "quadrangles" of 15 minutes on each side. Owing to the location of the State lines they do not coincide with the lines of these quadrangles, and there will be a number of quadrangles in the finished map which will embrace portions of adjoining states.

The total number of quadrangles lying wholly within the State, and those partly in other States will be about 240, and the completed map of the State will be composed of that number of sheets.

During the year 1908-1909 primary control was extended over the whole or portions of sixteen quadrangles. By triangulation over Accident, Frostburg, and Grantsville quadrangles, lying partly in Maryland, and over Berlin, Confluence, Hyndman and Meyersdale quadrangles lying wholly within the State, being portions of Bedford, Fayette and Somerset Counties. It was contemplated to extend the triangulation net from these quadrangles northward to connect with stations controlling the work heretofore done, but the weather conditions were such as to prevent the extension over the intervening quadrangles, (Windber, Somerset, Stahlstown and Ligonier).

During the same field season primary control was extended by traverse over eight quadrangles, in Butler, Mercer, and Venango Counties, as follows: Butler, Franklin, Hilliards, Mercer, Oil City, Stoneboro and Townsville.

Primary traverse was also extended over Emmitsburg and Hagerstown quadrangles, lying partly in Franklin County and partly in Frederick and Washington Counties, Maryland.

Vertical control was extended during the same season over portions of ten quadrangles, as follows: Franklin, Hilliards, Mercer and Stoneboro, in Mercer and Venango Counties; over Johnstown, Myersdale, Somerset and Windber quadrangles in Somerset County; over Bellefonte quadrangle in Center County and Fairfield quadrangle in Adams, Franklin and Cumberland Counties.

In all, portions of nine counties were covered by primary control, either horizontal or vertical, or both.

The detailed results of the primary control, both horizontal and vertical, will be found in the appendices to this report.

The primary control has been extended each year from the beginning of the Survey, until at the close of the season 1908-1909 it embraced, more or less completely, 180 of the quadrangles included, or partly included, within the boundaries of the State, and the vertical control has been extended until it reaches 182 quadrangles, more or less completely.

Of the completed work maps have been printed and issued by the United States Geological Survey of 129 quadrangles, a full list of which will be found in Appendix D.

It is imperative to the proper execution of the work that the control, especially the horizontal control, be kept well in advance of the detailed mapping. Owing to the reduced appropriation made by the last Act of the Legislature it was impossible to continue the Topographic work as outlined; indeed to satisfy, as far as possible, the demands for topographic work it had been planned to expend on topography \$15,000, to be met with an equal amount by the United State Geological Survey.

As the total amount of the appropriation for all kinds of work was but \$10,000 it was necessary to very greatly curtail the topographic work, and accordingly all control work was discontinued during the year 1909-1910, the available funds being used in completing those quadrangles most advanced. This practice cannot, however, be long continued, and it is necessary that control work be extended during the year 1911-1912.

Some portions of Pennsylvania are difficult to control, a fact that was apparent as far back as the time of the original running of the Mason and Dixon Line. That the more rugged portions of the State can be properly controlled, it will be necessary that the work be done on a larger scale than heretofore, to insure a high grade of work and do it in an economical manner. The quadrangles remaining in Somerset, Fayette and Westmoreland Counties should be at once controlled, to economically tie to the work heretofore done, while the demand for work from other portions of the State make it necessary that other control be instituted. This class of work should have an allotment from the State of at least \$5,000 during the coming year.

During the years 1908-1910 work was continued in detailed mapping of the following quadrangles: Bedford, New Kensington, Butler, Zelienople, Hamburg, Franklin, Bellefonte, Emmitsburg, Taneytown, and Fairfield. Of some of these the completed maps have been issued by the United States Geological Survey, and the others will be available as fast as they can be engraved.

GEOLOGICAL WORK.

From the beginning co-operative geological work has been continued. In all 31 quadrangles have been studied in co-operation, and six have been long under study by the United States Survey alone.

Of the thirty-one quadrangles worked on the co-operation plan reports have been issued on seventeen, these being in the standard folio form of the United States Geological Survey. In addition there have been issued by the National Survey six economic Bulletins, treating of seven quadrangles, and a number of short papers scattered through Bulletins and Reports of that survey. Of the co-operative work there was unfinished at the beginning of the year 1909-1910 fourteen quadrangles, on which final reports had not been made, some of which had been held back for several years.

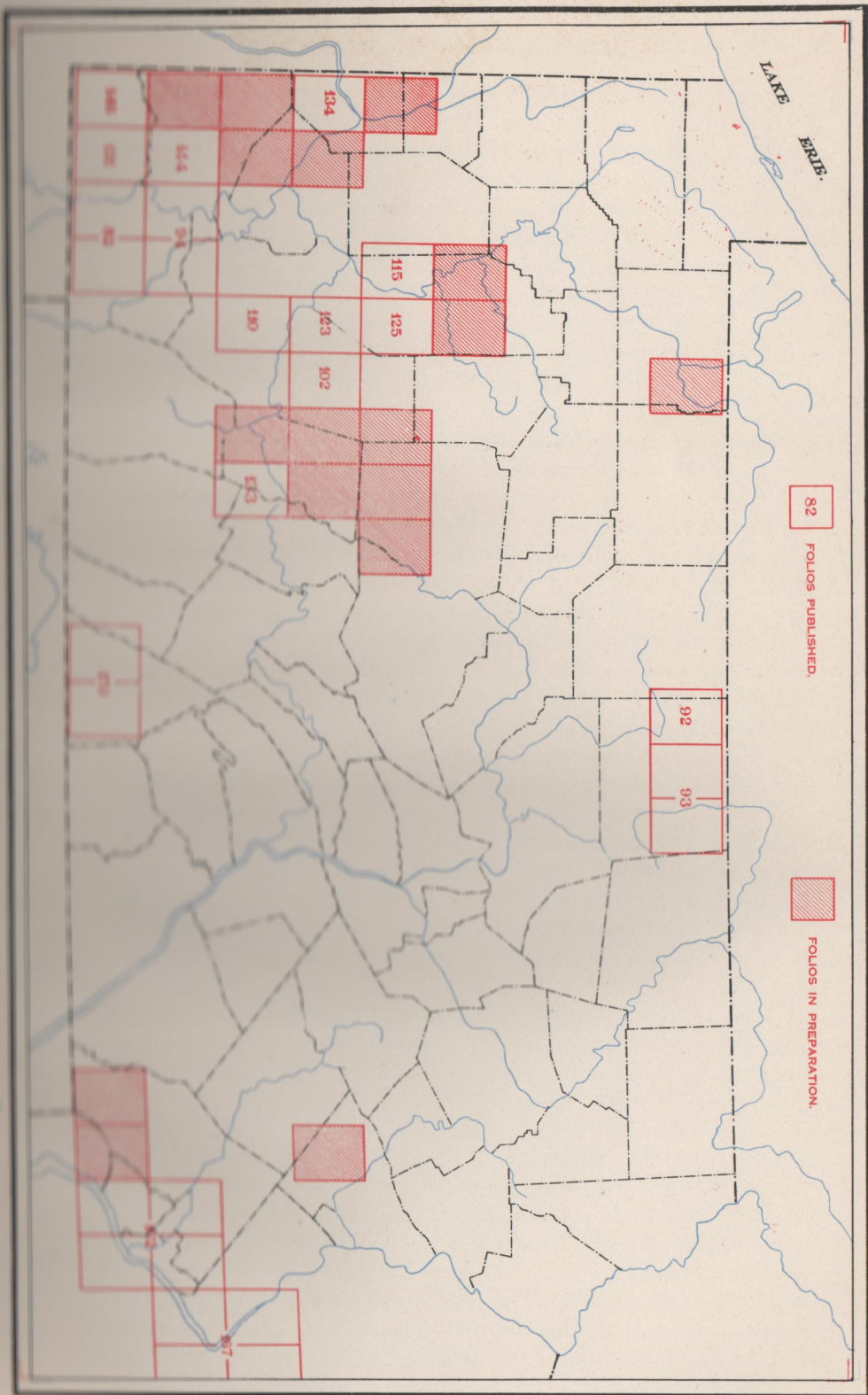
During the last two years Folio reports have been issued on the six quadrangles on which the United States Survey was working alone. These embrace four quadrangles in the Philadelphia region and two in Franklin County, where the work has been largely of a theoretical nature, rather than economic in character.

A list of publications issued by the United State Geological Survey, relating to Pennsylvania Geology, will be found in Appendix E.

The Act of Assembly of May 13, 1909, authorized the Commission to do work on behalf of the State, independent of the co-operative work with the United States Geological Survey, and issue reports on the same. Owing to the small amount of money available and the backward condition of the co-operative work, it was thought best by the Commission to urge the completion of the co-operative work upon the United States Survey, and allot whatever funds were needed toward bringing to completion the old work.

Accordingly, during the last year much progress has been made towards the completion of these reports.

The maps and text for the Warren Folio have been completed and the same is now in the hands of the printer, and will be ready for issue very shortly.



The Sewickly Folio has been submitted and is in process of printing, as is also the Johnstown Folio.

As a portion of the work on the Sewickly quadrangle a detailed Oil and Gas Bulletin was prepared, and the same will be issued as a report of the State Survey. This is perhaps the most detailed and exact report on this subject yet made and its value to the oil and gas interests in this quadrangle alone will be more than the whole appropriation to the work by the State. This report is now in process of printing and will be issued shortly.

The final report on the Burgettstown and Carnegie quadrangles will be issued as a double Folio. The maps are engraved and the report should be ready to issue in a short time.

The Foxburg-Clarion double Folio is printing. The maps are engraved and the report should also be ready to issue before the last of the current year.

In connection with the Clarion work an Oil and Gas Bulletin was prepared, which will be issued by the State Survey, the same now being in the hands of the printer.

The manuscript and maps of the Folio on the Claysville quadrangle have also been submitted, and this report should also be issued during the coming winter.

There are six other quadrangles on which co-operative work has been done, and the field work completed. It is expected the final manuscripts and maps for these will be ready for submission during the coming winter, and the results of the old unfinished co-operative work published.

The provisions of the last Act of Assembly, authorizing the Commission to appoint a State Geologist was not acted upon until October, 1909. Mr. Richard R. Hice, who had been a member of the Commission for a number of years, was elected to the position. Since then he has been engaged in the usual duties and labors of such positions.

Reports on the Oil and Gas Resources of the Sewickley quadrangle, and a similar report on the Clarion quadrangle, have been sent to the Department of Printing and Binding, and a progress map of southwestern Pennsylvania, showing the various oil and gas fields, the crop lines of the Lower Kittanning and Lower Freeport coals, and the area of the Pittsburgh coal, together with structural contours on the horizon of the latter seam over 25 quadrangles—an area of almost 6,000 square miles—probably the largest structural map, based on detailed work, yet issued—will be ready for the printer shortly.

In addition reports are at present under way on the Paint Ores of Pennsylvania; the Tale and Serpentine, and the Cement Industry of Lehigh and Northampton Counties, and the Graphite Ores of southeastern Pennsylvania.

GEOLOGICAL EXPLORATIONS IN PENNSYLVANIA.

A brief review of the development of geological work in the State is perhaps in place at this time, as showing the changes in attitude of the public towards this most important science.

The study of the geology of Pennsylvania is readily divided into a number of distinct stages. The earliest explorations were by private parties with the object of scientific study. At this early date Philadelphia was the home of a number of students of pure science, and the work then done was well up in the front rank of the geology of that time.

It is not the intention to give any long sketch of geological explorations in Pennsylvania. The work of the late Prof. J. P. Lesley,* written with a large fund of knowledge of, and personal acquaintance and friendship with the members of the First Geological Survey, is a work that will not be displaced, and from its pages the facts preceeding the time of the Second Geological Survey are taken.

The early explorations were scattered and of course but few of them were published. Strange as it may seem, probably the first sketch of the geology of any portion of the State was on "A Cascade near Ohiopyle Falls of the Youghiogheny," by Thomas Hutchins,† (1786). In 1820 Justice John Bannister Gibson‡ discussed the "trap Rocks of York, Cumberland and Lancaster Counties," taking a compromise position regarding the method of deposition, whether by fire or water.

In 1824 J. Finch|| wrote of the region near Easton, Pa. His report was accompanied by a small colored map, and in 1828§ George W. Carpenter, of Philadelphia, discussed the "Mineralogy of Chester county."

In 1830 the New York Legislature had under consideration the subject of boring for coal, and Professor Eaton stated the slates about Seneca and Cayuga lakes were the same as the slates of Tioga County, Pennsylvania. The geological knowledge of that day was not sufficiently advanced to know there was a difference of several thousand feet between the horizons of these measures. The studies of the New York geologists soon cleared the main features; and in 1833 Professor Eaton distinctly stated his confidence in the opinion of Cuvier, that "organized remains are true indexes to geological strata."

*Second Geol. Sur. of Penn'a, Vol. A.

†Transactions of the Am. Phil. Soc. Vol. II, O. S. p. 50.

‡Trans. Am. Phil. Soc. Vol. II, N. S. p. 156.

§Silliman's Jour. Vol. VIII, p. 236.

§Silliman's Jour. Vol. XIV, p. 1.

THE GEOLOGICAL SOCIETY OF PENNSYLVANIA.

What has been said is sufficient to show the interest in geological study, but it also shows how little was really known as late as 1830. In 1832 seven men of science organized the Geological Society of Pennsylvania, with Justice John B. Gibson as President. One of the avowed objects was to secure a State survey and it is due to the efforts of this society, which rapidly grew in numbers, that the First Survey was authorized.

The Society endeavored to have an Act passed by the Legislature of 1832-3, but the bill reported by the Committee, appropriating \$15,000, failed to pass. At that time other States realized the importance of geological studies and Tennessee, South Carolina and Massachusetts had already directed surveys to be made. The bill again failed to pass the Sessions of 1833-4 and 1834-5, and in the meantime Virginia, New Jersey, New York, Connecticut and Maine had organized State surveys, in addition to the States above mentioned.

In 1836, however, the efforts of the friends of the science bore fruit. A resolution passed both houses and was approved by the Governor. The direction of the Survey was not placed in the hands of the Geological Society, as contemplated by the earlier bills, but fortunately for Pennsylvania and for science was given in charge of Professor Henry D. Rogers, brother of William B. Rogers, then State Geologist of Virginia. With the institution of the State Survey the Geological Society vanished. It had accomplished its work. The best geological literature and the most accurate and complete reports made up to the time of its dissolution (1836) are found in its transactions, and it is to its efforts the survey of the State was due. The people of Pennsylvania owe a lasting debt of gratitude to that organization and to its members.

FIRST GEOLOGICAL SURVEY.

The act of the Legislature authorizing this Survey was dated March 29, 1836, and authorized an annual appropriation of \$6,400 for five years. Prof. Henry D. Rogers was appointed State Geologist. It seems remarkable what great results were derived from the first few years' study. During the first year the grand features of the formation of the State were determined, and found to harmonize with the determinations of the New York geologists on the north and with

Virginia to the southward. The main formations were numbered from I to XII, number I being the limestone of the Lebanon valley and number XII the Coal Measures, and the numbers then given have remained with us.

The second year's work was a more detailed study of the Anthracite Region in the main, and in his report of this year's work Prof. Rogers says:

"In taking a general review of the extensive series of our Appalachian formations, now for the first time systematically classified, our attention is forcibly arrested by their vast thickness, the immensity of their range, and the inexhaustible stores of mineral wealth they contain.

"From the base of the entire series, where the bottom of the lowest sandstone is in contact with the primary rocks of the South Mountain, to the uppermost beds of the Anthracite Coal Measures, the absolute depth of this enormous group of strata in our counties east of the Susquehanna cannot be less than *forty thousand feet*."

and he further remarks that, with a few other strata, "They comprise three-fifths of the territory of the United States east of the Mississippi," and that "Pennsylvania holds the *key* to the geology of many of the other states."

In the third year of the survey (1838) it was found that the coal series of Western Pennsylvania were not one, but consisted of two distinct series, separated by a series of rocks containing no workable coals; that there were six bituminous coal basins; that the number of anthracite beds had been greatly exaggerated, and that the anthracite coals were also in two series, separated by a barren series of rocks. In this season it was also found the anthracite coals were not older than the bituminous, but all were parts of what was at one time a vast coal basin, extending originally not only over the coal fields as we now find them, but over vast regions from which they have entirely disappeared by erosion. This year, 1838, marked the beginning of topographic geology, and it was born in Pennsylvania.

The survey continued, giving more attention to details throughout the State, during 1839, 1840 and 1841, and it is remarkable the quality of the work, with the very limited appliances at hand. In 1840 the expenses reached \$17,800, a much greater sum *comparatively*, and almost twice as much *absolutely* as is now being expended for both topographic and geologic work.

The Legislature failed to make an appropriation at the session of 1841-2 and the State Geologist was compelled to disband his organized force and discontinue work. The failure of the appropriation was charged to the "financial embarrassments of the Commonwealth," but this was by no means the whole reason. Where now a trained mine superintendent wants and requires careful geological work to

accomplish his ends, then the "practical man" was in control and opposed all "theories." There was then, as now, a demand for work from all parts of the State, each county wanted to be first served, and the State Geologist was much embarrassed from this cause, for the small appropriation would admit of but a limited amount of work each season. Geological work is slow, and the appropriations for the First Survey were not sufficient to publish the results as obtained. Not only so but necessarily much of the work was of a general nature. As Professor Lesley has said of a survey:

"Its first stages are rapid and of the nature of reconnoissance, or general survey of the country to be afterwards better surveyed. As it advances it discovers its own future work, and prepares itself to do it. The longer it lasts the more local, special, exact and important it becomes. New difficulties arise and fresh problems call for interpretation. The publication of what is discovered or determined ought to follow step by step its discovery or determination. To carry on field work straight ahead never stopping to revise, collate, compare, calculate, map and publish, is as absurd for a survey as it is improvident for the Commonwealth. But to do this is to make the survey practically perpetual. If the field work of six summer months be followed by six months of office work in winter (and no less will answer) and the results be published immediately for the use of the citizens, there will be plenty of demands for field work on the same ground the next summer."

The first survey was at an end, and the results of its work unpublished. Mr. Rogers continued to labor and tried to reduce the incomplete work of his assistants to harmony. He was without salary, and most of his time was, *per force*, spent in work for private clients. The investor realizes the advantage of expert knowledge. Still some work was accomplished towards the adjustment of the mass of materials, and in 1848 an effort was made to have part of the results published, but failed. It was again taken up in 1850 and after a thorough investigation a special committee recommended an appropriation of \$32,000 to complete field work and publish the report.

Up to that time New York had expended over \$200,000 on its survey, and the work there has not stopped since its inception, and is still in progress. Under the provisions of this act field work was carried on actively during the years 1851 and 1852, and Professor Rogers spent the years 1852, 1853, 1854 in the preparation of the final report, revising many portions of the work himself. The final report was due in 1855, but the firm in Philadelphia with whom the contract had been made, dissolved and passed out of business, and a report of a select committee of the Senate in 1855 recommended that a contract be made with Mr. Rogers himself, giving him a period of three years in which to complete the work, he agreeing to renounce his salary for that time. The recommendation of the Committee was adopted and the contract awarded to Mr. Rogers.

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It is not in place to discuss the report. It consists of two volumes, 1,631 pages, with 778 wood cuts, seven plates of sections, 23 of coal fossil plants, 6 plates of sections along rivers, 2 plates of vertical sections, and 43 single plates of views illustrating the geology of the State. It was a report unsurpassed at that day, both in its style, and in the text. The statements are clear and concise, and the conclusions, even where now known to be wrong, are clearly stated and carefully drawn.

From the time of the completion of the final report of the First Survey in 1858, to the inauguration of the Second Survey in 1874, the State of Pennsylvania, notwithstanding its mineral resources and the necessity of working the same with the utmost economy in every way, did nothing to encourage the study of the unsolved problems left by the First Survey, and nothing to keep abreast of the advances made in the intervening time. It is true considerable geological work was done, and done in many cases by competent men, but it was all for private gain, the records of the work were preserved with the utmost secrecy lest some competitor might gain them, and it was only a few disconnected observations that were published to the world in scientific journals, a source of information of no value whatever to the layman, and so scattered as to be obtained by but few of those interested in the development of the State.

It is not of value here to give any record of these scattered reports. Much of the private work was available to the geologists of the Second Survey, for the interest awakened by the resurvey of the State was far reaching, and with true scientific instincts many private surveys were offered that the resultant work might be the better done. This is the common experience of official surveys, especially so when divorced from politics, and when it is known the private records will not be used for personal gain, or individual publication, and the results of the study when published will be known to all interested.

SECOND GEOLOGICAL SURVEY.

This Survey was authorized by Act of Assembly, approved May 14, 1874. The Board of Commissioners provided by that Act was promptly appointed, and met for organization June 5, 1874. At this meeting Prof. J. P. Lesley was appointed State Geologist. Three weeks later Professor Lesley had prepared a plan for the Survey, had selected assistants, and, on the approval of the Board, work was started. Although the season was short and the work of getting a

new organization started was great, entailing a trip to Europe by the State Geologist in August of 1874, yet a number of reports, all however of a preliminary nature, were under way during the winter of 1874-5.

The winter of 1874-5 was late and field work was continued almost to the end of 1874. The reports under preparation during that winter were ten in number and some good work was accomplished in the four months of field work. No profound discoveries, like those of the first five years' work of the First Survey, were made; but the work resulted in clearing up some of the problems left over from the First Survey, just as work now results in determining questions left unsettled by the Second Survey.

The Survey suffered from the want of accurate maps, there was then, as there are now, aside from the portions of the State topographically surveyed, no accurate maps of the State; indeed in some of the "official" maps towns are located several miles distant from their true location. The want of good maps was early seen by the Second Survey, and much of its money was spent in preparing them of special localities, especially of the Anthracite region. In the second report to the Legislature the necessity of accurate maps was made plain, the report saying:

"But the work of the Survey cannot be said to be complete until topographical control maps of the entire Bituminous Coal region of western Pennsylvania are provided. This work, now necessarily postponed, would require the entire instrumental force of the Survey for at least two full seasons. Other parts of the State, especially the region lying southeast of the South Mountain range, need the same careful, instrumental, topographical mapping to make their geology clear."

The Survey continued from year to year with the unfavorable conditions which always attend a great work that may be cut off at any time. With added experience the more difficult portions of the State were attacked. Although the Anthracite region had been the most thoroughly studied portion of the State by the First Survey, and the work there had been revised just preceeding the publication of the report of 1853, and a large mass of accurate surveys of the various Coal Companies was placed at the command of the Survey, yet the problems involved required a detail of work that was unexpected and an outlay not provided for in the estimates. The quality of the work done and its value to the public have, however, more than repaid the State for the additional outlays made.

In 1887 an appropriation of \$88,000 was made, with the express provision that the Survey must be completed by June 1, 1889. A geological survey can never be *completed*. In the report of the Commission to the Legislature of the work for 1891 and 1892, which report

was supposed to be the last communication of the Commission, several cases were given where a survey was badly needed, but by the action of the Legislature some work was left undone, and some in an unfinished state, and notwithstanding the fact that much of the work accomplished was the most detailed yet attempted and of the greatest value to the people of the State, yet the necessity for further work was only the more apparent.

The library of the Survey was removed to the State Library at Harrisburg and the collection of specimens deposited with the Academy of Natural Sciences at Philadelphia, subject to the right of the State to make any other disposition of it, and the instruments were sold.

In the report referred to the Commission said:

"There are certain areas of the State which it would be desirable to have surveyed a second time, such for example are Potter and Tioga Counties."

In speaking of the Broad Top region in Huntingdon and Bedford Counties the report says:

"This important coal field, although limited in extent to eighty square miles, should be surveyed with the same minute accuracy which characterizes the published sheets of the Anthracite region. Elaborate topographical surveys of the field have been made in the past years and never published, because they were in an incomplete condition, and these surveys ought to be made complete and published.

"The South Mountain of Franklin, Cumberland, York and Adams Counties has been topographically surveyed. Since these surveys were made a wholly new aspect has been given to the geology of the South Mountain by the investigations of Dr. Walcott of the U. S. Geological Survey, who has found for the first time the lower Cambrian fossils in the quartzite of the mountain mass, and in the limestone of the York County basin.

"It is desirable to make further investigations of the rocks of the Philadelphia belt through Delaware, Chester and Lancaster Counties to the Maryland line and especially to determine the true relations of the chrome iron rocks.

"One of the most complete surveys ever made in the country is acknowledged to be by all those interested in the subject, that of the Anthracite region. But experience has shown—not only its usefulness—but the necessity of its continuance from year to year indefinitely. This can only be the work of a permanent Geological Bureau, under the direction of geological experts not interested commercially with the output of Anthracite coal.

"To some extent the statement just made respecting the Anthracite region holds good of the Bituminous regions of western and northern Pennsylvania.

"But no statement can be made in terms too strong respecting the oil and gas surveys of the State. These require imperatively to be continued from year to year as the work of a permanent geo-

logical bureau, for there is no other apparatus for thoroughly intelligent and comprehensive discovery of facts now of vital importance to the great interests of our western counties. The gas and oil work of the Geological Survey has been of incalculable importance to those industries, and the people of Western Pennsylvania, acknowledging the fact, will cordially support an act of the Legislature which has in view the confirmation and increase of our geological knowledge on these subjects.

"The preceeding statements show an enormous amount of work has been done in the eighteen years since the organization of the Survey. They also show that we know of many things which remain to be done. Besides these known omissions there is a great unknown field. The work of a geological survey is never done in one sense. In a territory so vast as Pennsylvania new discoveries, or supposed discoveries, are continually being made. Such discoveries should, as soon as announced, be subject to investigation by competent experts. It is just as important to the public that they should be cautioned against extravagant claims of interested parties, as that genuine claims should be sustained.

"For these reasons the Board reiterates its former recommendations that the Geological Survey should be made a permanent bureau and that a regular, moderate, annual appropriation should be made for its maintenance.

"The State of New Jersey with one-sixth of our area, and less than the hundredth part of our mineral wealth, finds it advantageous to appropriate \$8,000 annually to its Geological Survey. Its annual reports are full of valuable and interesting matter."

The work of completing the reports from the data collected by the geologists of the Second Survey was a great task. The Legislature appropriated \$10,000 in 1891 to complete this work. In 1891 the work of getting the final report ready for the printer was in progress, and the last maps of the anthracite surveys were issued. Fulton's maps of Somerset and Cambria Counties also were issued during the same year. The office force was reduced in 1892. The State Geological map was issued, and work continued on the remaining volumes. The appropriation of \$10,000, made in 1891, was exhausted in August, 1894.

In view of the serious illness of Professor Lesley the Board employed Mr. E. V. d'Inwilliers to complete the work on the Bituminous districts and Mr. A. D. W. Smith to complete the Anthracite region, two members of the Board personally advancing \$500 each for the expenses of these gentlemen, not for compensation for their time and service; for this they trusted the next Legislature. Besides these sums Professor Lesley personally advanced money for office expenses, so that there was owing for services and money advanced by Professor Lesley almost \$5,000.

With the small force at work the following reports were issued: Halberstadt's map of the Bituminous Collieries; Atlas of Bucks and Montgomery Counties; of Union, Snyder, Mifflin, Schuylkill and

Carbon Counties, and Volume 3 of the Final Report, most of the latter volume being then in print, while the reports on the Anthracite and Bituminous regions were practically ready for the printer.

In its Final Report the Commission made two recommendations which they say were more and more impressed on them as time went on:

1. The importance of a topographic survey of the State.
2. The continuance of the survey.

They say:

"The survey ought never to stop. After a report is published every new discovery makes it more and more incomplete. The Survey is daily receiving inquiries from all parts of the State. It ought to be continued so there would always be an official authority to answer questions and make new investigations. The Geological Survey of Great Britain was begun in 1838 and is still in progress, with a large annual appropriation. New York and New Jersey also continue their surveys."

With the publication of the last volume of the Final Report the Second Geological Survey of Pennsylvania came to an end. It had performed a great work and stands a monument to the skill and energy of the State Geologist and his assistants. Especially is this true of the work in the complicated Anthracite region and the detailed work there done is still of the greatest value. Dr. David White, the Paleobotanist of the United States Geological Survey, says of it (U. S. Geol. Survey, 20th Annual Report, part II, p. 760), "The Atlas of the Southern Anthracite field in Pennsylvania represents the most minutely detailed and most excellent economic work on sedimentary deposits that has yet been accomplished over an extensive area in this country."

Relatively, it did not cost the State as much as the First Survey; *practically*, it has repaid the citizens of the State many times its cost. The necessity of a continuing survey can hardly be stronger put than in the reports of the Commission of that Survey. The work stopped 20 years ago, and it is no disparagement to the Second Survey to say the need of new work is as imperative as it was in 1874. Our knowledge of geology has doubled in the last twenty years. New appliances and methods of study have developed; commercial activity, guided by the work of the Second Survey, and supplemented by private investigations, has increased many times. Never was the necessity for accurate knowledge so imperative, and it is still true the work can only be done by a State organization.

The entire world recognizes the importance of geological work. Japan, India, Australia, New Zealand, South Africa, Great Britain, Europe generally, Brazil, and South America, Canada and Mexico have official surveys, while geological exploration of special subjects

are common in still other regions. At home we have the United States Geological Survey, but in addition we have it as the testimony of Maine, New Hampshire, Vermont, Connecticut, New York, New Jersey, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Tennessee, Kentucky, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, North Dakota, South Dakota, Missouri, Kansas, Arkansas, Oklahoma, Colorado, and some of the other States that it is the duty of the State to have such continuing organizations as recommended by the board of the Second Survey.

The Topographic Survey, as repeatedly recommended in the reports of the Commissioners of the Second Survey, has been in progress since 1899, and with some portions of the State mapped earlier by the United States Geological Survey, we now have about one-half of the State mapped, and at the last session of the Legislature geological work was authorized, but with appropriation too limited to supply the demands for work. On a later page will be found a table of the appropriations of a number of States, with the value of the mineral products of each, from which the relative appropriations for Pennsylvania work will be readily seen.

THE PRESENT SURVEY.

From the time of the last appropriation for the amounts due for work on the Final Report of the Second Survey, nothing was done with the recommendations of the Commissioners of that Survey until the Act of April 28, 1899, which made an appropriation for joint work with the United States Geological Survey. The main work contemplated by that Act was the preparation of a contour topographic map of the State and an appropriation of \$20,000 for each of the two ensuing years was made, on the condition that the United States Survey should expend an equal sum on the work.

During the closing years of the Second Survey the Board repeatedly recommended such a map to be made jointly by the State and the U. S. Survey, and at that time the United States Survey, as appears from the reports and recommendations of the Board, was willing to pay three-fourths of the expense. While it would appear on the face of it that the State lost by not accepting the earlier propositions of the National Survey, yet in view of the much higher grade of work now being done the State is certainly not a loser in any way in paying the increased cost. The value of the maps published is recognized by all engineers, and no office is now equipped which does not have

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a full set of maps issued for the territory where work is being done or contemplated. The progress of the co-operative work has been given in the several reports of this Commission, and in this volume.

THE PRODUCTION OF MINERAL PRODUCTS IN PENNSYLVANIA.

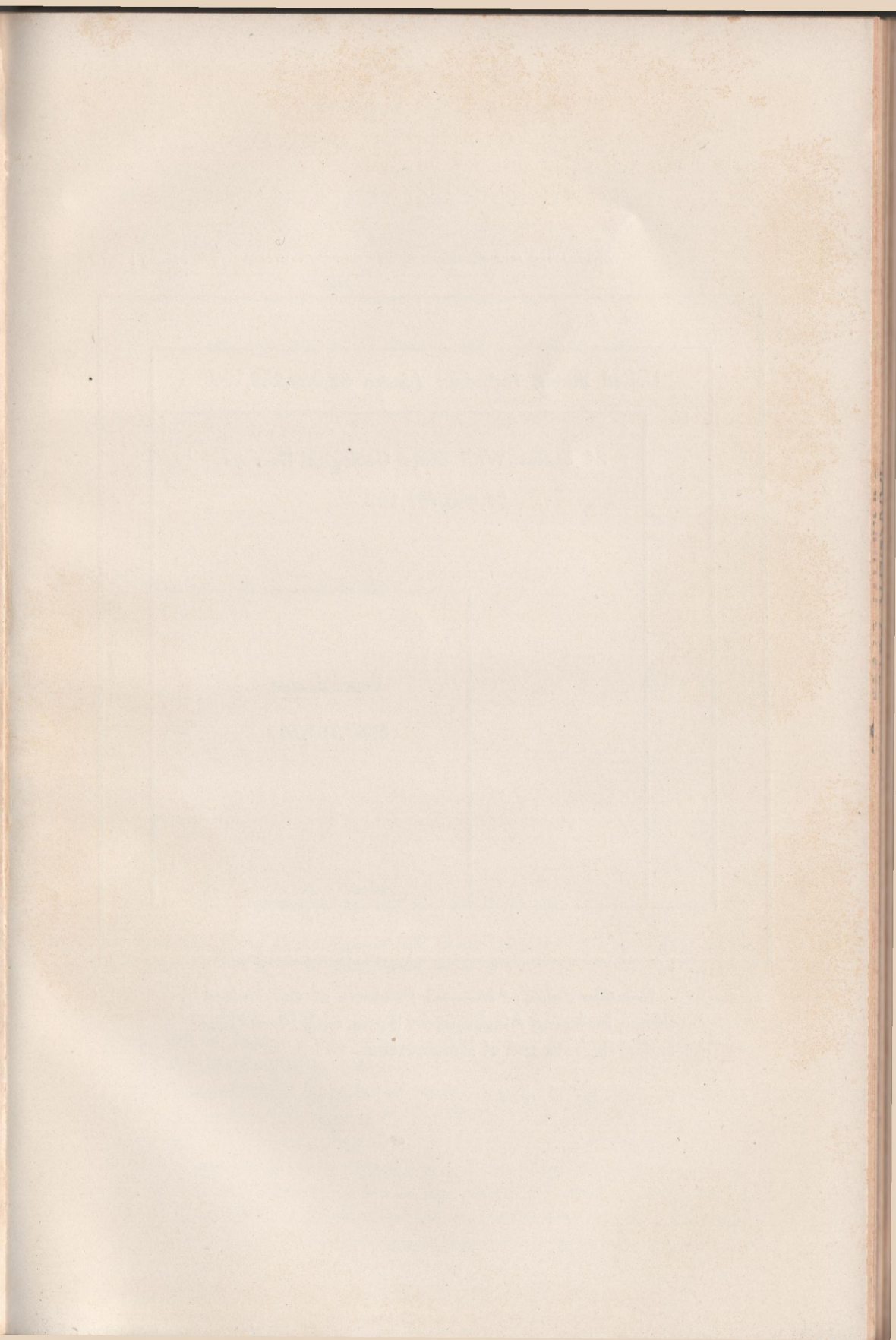
Few of us realize the immensity of the mineral products of Pennsylvania. The reports of the United States Geological Survey on the Mineral Resources of the United States have been of the greatest value in giving us the figures showing these various products. It is not in place in this report to give any detail of the mineral industry of the State. This can be had from the several reports of the United States Survey. It is, however, in place to call attention to the relative rank of the State as regards mineral products that we can see the necessity of properly conserving our resources in this direction.

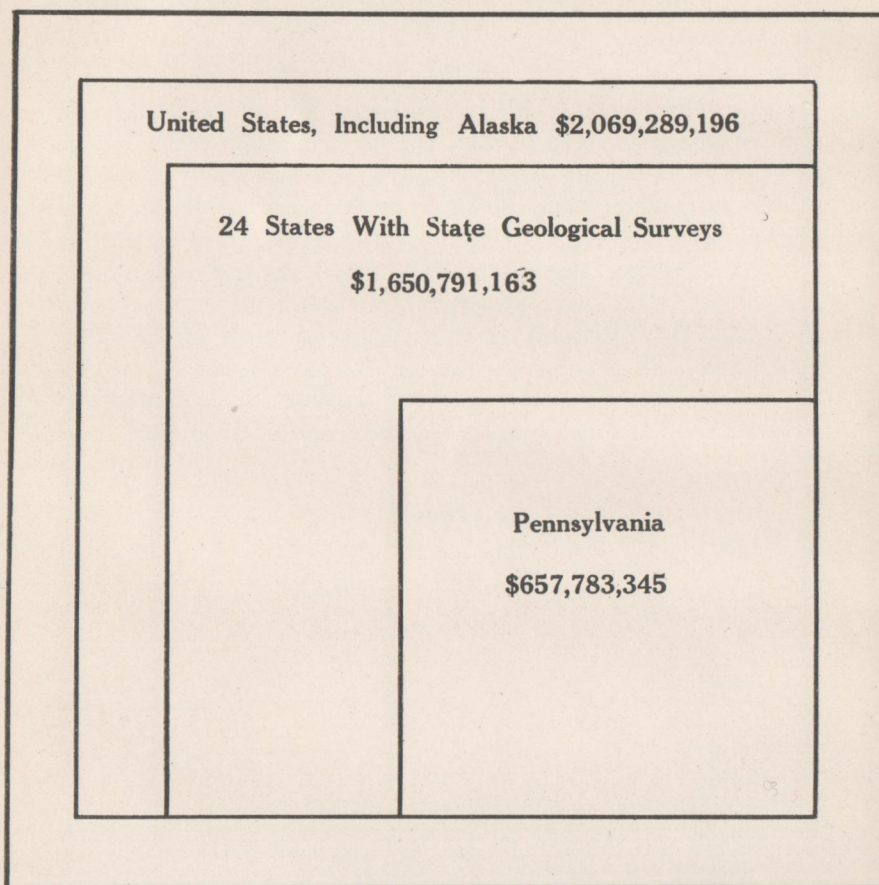
In the Report on Mineral Products for the year 1907, we find the output and value of the mineral products of this State are as follows:

TABLE 1.

Product.	Quantity.	Value.
Cement:		
Natural, barrels, -----	625,871	\$263,969
Portland, barrels, -----	20,393,965	19,698,006
Clay products, -----		20,291,621
Coal:		
Anthracite, long tons, -----	76,432,421	163,584,056
Bituminous, short tons, -----	150,143,177	155,664,026
Glass sand, short tons, -----	370,977	489,989
Graphite, pounds, -----	1,674,000	51,960
Iron, pig, long tons, -----	11,348,549	234,952,000
Lime, short tons, -----	655,166	2,075,842
Metallic paint and mortar colors, short tons, -----	10,327	127,973
Millstones, -----		2,016
Mineral waters, gallons sold, -----	1,287,063	235,807
Natural gas, -----		18,844,156
Ocher, short tons, -----	8,047	76,816
Petroleum, barrels, -----	9,909,306	17,579,706
Sand and gravel, short tons, -----	5,428,471	2,292,579
Sand-lime brick, -----		48,410
Slate, -----		3,855,640
Stone, -----		9,132,372
Other products, -----		6,874,095
		\$657,783,345

The total value of mineral products for 1907 for the whole of the United States, including Alaska, was \$2,069,289,196, so that the value of these products from Pennsylvania was practically *one-third* of the entire United States, and of those products *necessary* for the use of man far exceeded that proportion.





Relative Value of Mineral Products of the United States, Including Alaska; of 24 States with State Geological Surveys and of Pennsylvania.

A number of states have State Geological Surveys, and the following table gives the appropriation of 24 states with State Geological Surveys, and the value of the Mineral Products of each.

TABLE 2.

State.	Appropriation for topography and geology.	Value of mineral products in 1907.
Alabama, -----	*\$7,500	\$52,136,749
Arkansas, -----	*5,000	6,386,747
Colorado, -----	*10,000	71,105,128
Connecticut, -----	3,000	3,389,519
Florida, -----	7,500	7,365,754
Georgia, -----	10,000	6,641,003
Illinois, -----	25,000	145,768,461
Indiana, -----	8,240	39,141,217
Iowa, -----	8,000	17,623,094
Kansas, -----	*3,000	28,577,044
Maryland, -----	15,000	19,356,250
Michigan, -----	10,000	70,073,920
Mississippi, -----	5,000	1,024,332
Missouri, -----	15,000	53,129,431
New Jersey, -----	16,500	32,800,239
New York, -----	†28,080	68,762,815
North Carolina, -----	10,000	2,901,381
Ohio, -----	26,860	207,657,330
Oklahoma, -----	15,000	26,908,968
Pennsylvania, -----	10,000	657,783,345
Vermont, -----	2,400	9,464,857
Virginia, -----	10,000	19,313,182
West Virginia, -----	30,000	92,487,960
Wisconsin, -----	20,000	13,832,395
		\$1,650,791,163

*Not including salary of State Geologist.

†Not including topography.

An analysis of these figures will show that the 24 states with State Geological Surveys produced over *three-fourths* of the entire value of the mineral products of the entire United States, including Alaska, and the relative value of the products from the entire United States, from the 24 states given in the above table, and from Pennsylvania is shown graphically by reference to Figure 1.

The commanding position of Pennsylvania in the line of mineral products is however shown by the Report on Mineral Products in other ways. We are accustomed to think and talk of the great value of the minerals in those states west of the Mississippi River. Looking at the statistics as given in the report, we find that the entire value of the mineral products of *all* the states west of the Mississippi in 1907 was but \$549,099,843, which amount includes over \$20,000,000

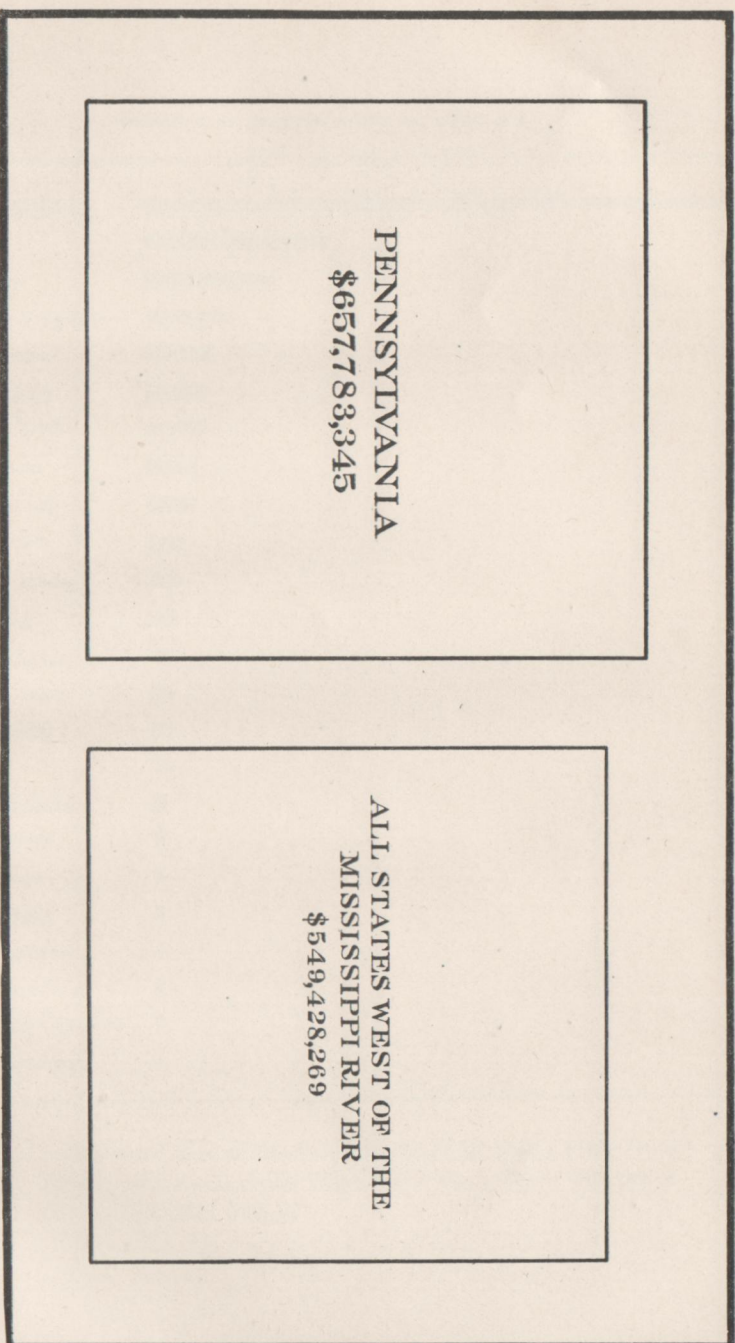
produced in Alaska. Fig. 2, will show this value as compared with the product of Pennsylvania, which exceeds them all by the great sum of \$108,000,000.

That we can the better understand the commanding position of Pennsylvania as regards the other states given in Table No. 2, reference is made to Figure 3, where is shown in a graphic manner the relative value of the Mineral Products of the 24 states with State Geological Surveys, Pennsylvania leading with more than three times the value of the products of Ohio, the second State. Some may say this is due to the enormous production of pig iron by Pennsylvania, but if we eliminate the pig iron from the figures, we find that Pennsylvania still has a mineral production of \$423,000,000 as compared with that of Ohio (less pig iron) of less than \$102,000,000 or that Pennsylvania still leads, but this time with over *four* times the value of the Ohio products.

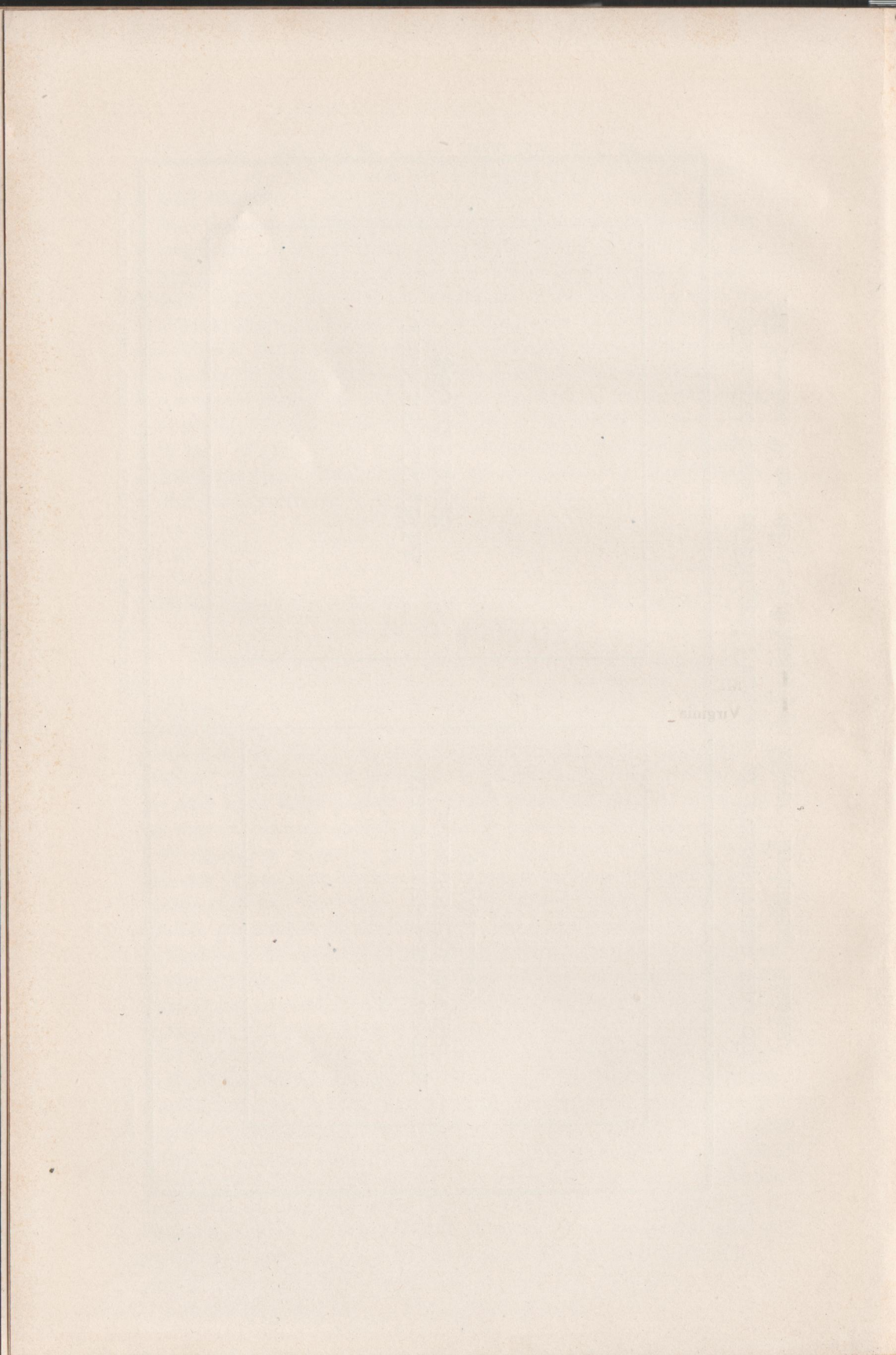
THE GEOLOGICAL WORK OF THE U. S. GEOLOGICAL SURVEY IN PENNSYLVANIA.

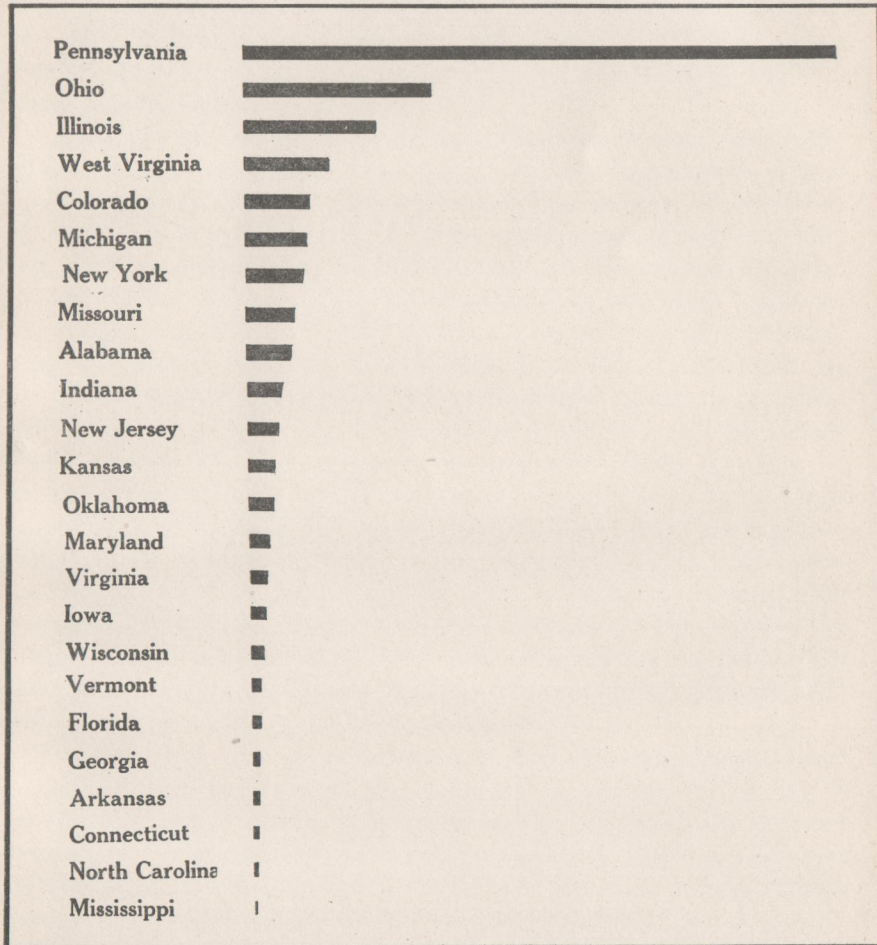
There has been a marked change in the policy of the United States Geological Survey as regards geological work in the eastern portion of the United States. Notwithstanding the facts that the greatest production of minerals is in the east; that the mines in the east have been worked for many years, so that in many cases the end of mining operations under present conditions is readily seen; that the minerals produced in the east are near to market and can be put into use at a minimum of expense as regards cost of transportation; that they are near, indeed in the midst of the densest population in the country; that for all of which reasons it is necessary the greatest attention be given to the cost of production, to the saving of the waste products, to the gaining of the entire value of the mineral present; yet the result of the policy of the United States Survey is to abandon work in the east.

Of the appropriations made by the last Congress for geological work, it has been arranged by the United States Survey to expend over 72 per cent. in that portion of the country lying west of the 97th degree of longitude. These states produced in 1907 but \$426,000,000 dollars in mineral products, a little over *five-eighths* of the product of Pennsylvania alone, and but little in excess of *one-fourth* of the products east of the Mississippi River. The proportion allotted by the National Survey to Pennsylvania is so small as to hardly bear any comparison with the value of the mineral products of the State.



Relative Value of Mineral Products of Pennsylvania and of
All States West of the Mississippi River, Including Alaska.





Relative Value of Mineral Products of 24 States With State Geological Surveys (Total Value More Than Three Fourths of the Entire United States).

West of the 97th Meridian there will be expended over \$216,000 for geology by the National Survey, or one dollar for each \$2,000 value of mineral products, while for each dollar of the \$85,000 or less expended for work east of the Meridian named the value of the mineral products will be about \$20,000. Of the money spent for work in the eastern portion of the United States, there will be expended in Pennsylvania *perhaps* one per cent. of the whole appropriation, or less than \$3,000, which means that this State will produce over \$200,000 of mineral products for each dollar expended by the National Survey within its borders.*

It must not be thought, however, that there is not some reason for a part of this very great irregularity in the expenditure of the National Survey. One of the purposes of that survey, as expressed in the Act of Congress creating it, is the classification of public lands. This is a great work, and one that cannot be done too thoroughly. It would seem, however, that the classification of public lands, as now made, is not such a classification as was contemplated when the work was placed upon the National Survey. This classification, as now made, enures directly to the benefit of the Public Land Office, and we see almost daily how the valuation of some part of the unsold public domain has been advanced a number of times in value by the classification made by the Geological Survey. But it does not seem right, or just in the least, that the expense attending this classification should be borne by the *appropriation for geological work made to the Geological Survey*, but such is the fact, and is the reason assigned for the disproportionate allotment of the funds of the United States Geological Survey and consequent discrimination against the eastern portion of the country, against the greatest mineral industries, against the mass of the people.

It is due, in a very great measure, to this growing disposition of the National Survey to withdraw from work in the eastern portion of the country that the necessity for work by the various States becomes imperative. A comparison of the figures given in Table 2 will be of interest in this connection, as showing the aid given by the several States to the mineral industries within their borders.

It is evident that, other things being equal, the aid given by a State towards the better knowledge of its minerals, the methods of producing the same, the reduction of waste in mining, the saving of waste products, and other things that go to make up the value of a geological survey, should be in proportion to the value of the annual production. Viewed in this light the State of Pennsylvania stands far in the background. Taking up the list of States with Geological Surveys (Table No. 1) and comparing the amount of the annual appro-

*Based on the production of 1907.

priations made by each State for geological work (including in most cases topography) with the value of the mineral products of the State, we have the following table:

Table 3.

VALUE OF MINERAL PRODUCTS FOR EACH DOLLAR OF APPROPRIATION FOR GEOLOGIC AND TOPOGRAPHIC WORK.

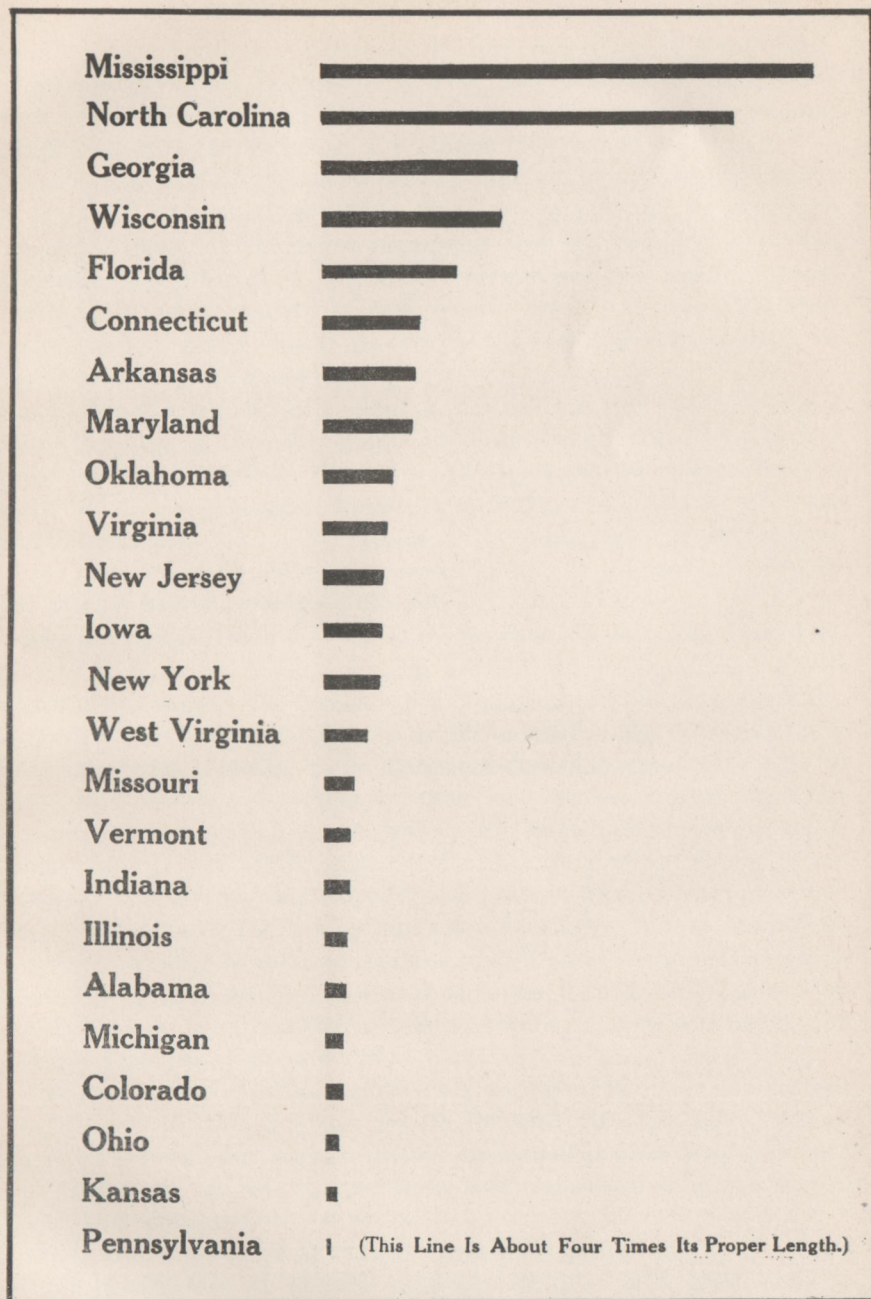
Alabama,	\$6,951
Arkansas,	1,277
Colorado,	7,110
Connecticut,	1,130
Florida,	982
Georgia,	664
Illinois,	5,830
Indiana,	4,750
Iowa,	2,203
Kansas,	9,526
Maryland,	1,290
Michigan,	7,007
Mississippi,	245
Missouri,	3,542
New Jersey,	1,989
New York,	2,440
North Carolina,	296
Ohio,	7,731
Oklahoma,	1,794
Pennsylvania,	65,778
Vermont,	3,948
Virginia,	1,931
West Virginia,	3,083
Wisconsin,	692

The relative appropriations for geological work (including topography in most cases) is shown better by reference to figure 4, where is shown the relative amounts expended by each of the 24 states given in Table 1 for each \$1,000 of annual value of mineral products. Viewed in this relationship Mississippi stands first as regards the help given by technical work, followed by North Carolina and Georgia, while Pennsylvania is at the end of the list, giving less than one seventh as much as Kansas, which appropriates almost one-tenth of a mill for each dollar of mineral production.

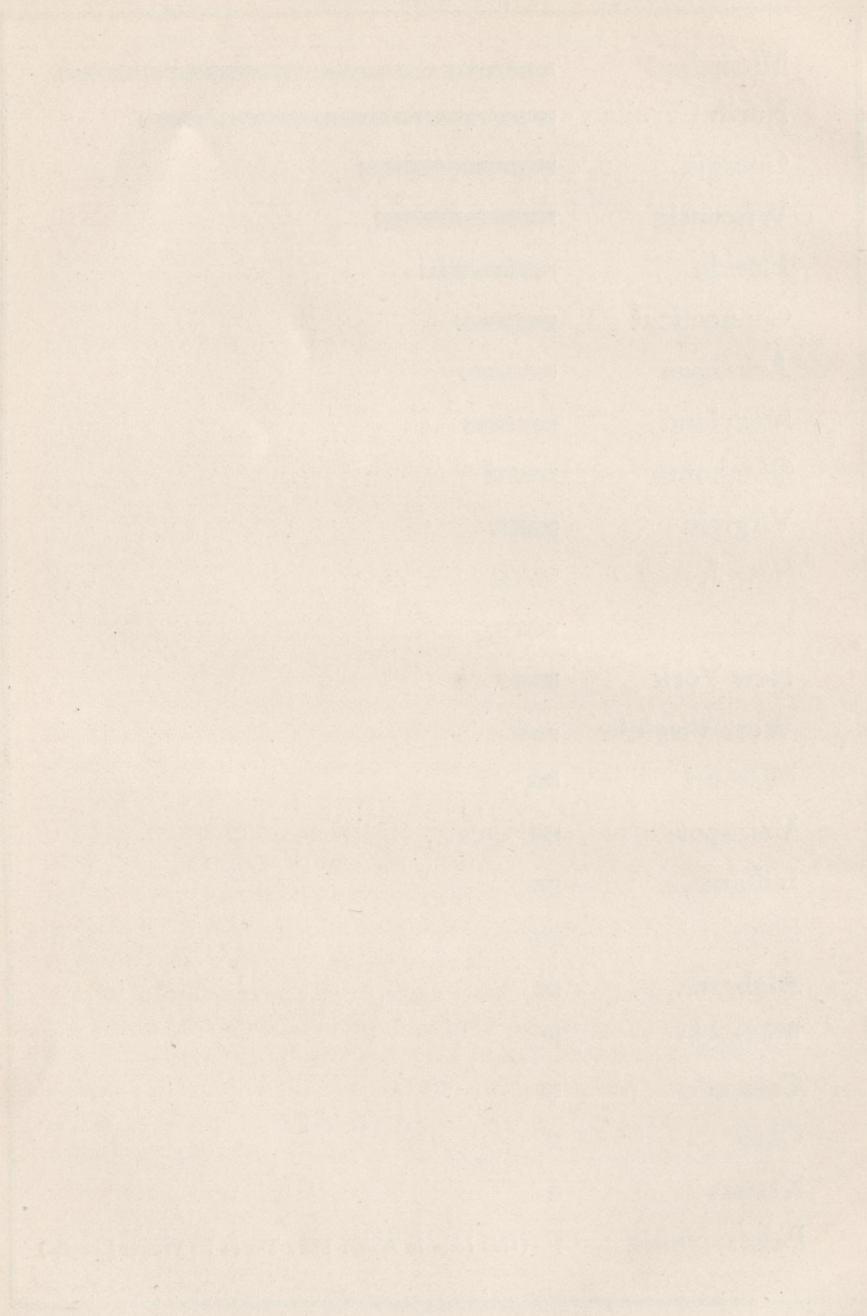
The appropriation of Pennsylvania is but one dollar for each \$65,700 in value of the annual mineral products, as compared with one dollar for each \$2,440 in New York, one dollar for each \$1,989 in New Jersey, one dollar for each \$1,290 in Maryland, one dollar for each \$3,083 in West Virginia and one dollar for each \$7,731 in Ohio. We certainly cannot be proud of the position of our own State.

RECOMMENDATIONS.

The need of greatly increased appropriations for both topographic and geologic work cannot be put too strongly. As stated on a previous page, your Commissioners have had to greatly curtail the topo-



Relative State appropriations for Geologic and Topographic work for each \$1,000 value of mineral products.



graphic work, confining it entirely to the completion of those quadrangles which were farthest advanced, and cutting of all control work. The demands for topographic work are constantly increasing and the advantages are being more appreciated every day.

During the coming two years primary and secondary control should be extended over portions of the State which have as yet not been touched. Some of the more important are the completion of the Somerset-Bedford region, where several quadrangles remain uncontrolled. Primary control should be extended over the Clearfield region, and in doing this it should tie up with the control work in New York along the State line.

Additional work should be done in the northwestern portion of the State and also in the central and northeastern portions. To do this work properly requires time, and the appropriations made for the work of the Commission should be sufficient to allow of at least \$5,000 being allotted to this branch of the topographic work for each of the next two years, which sums will be met by an equal amount by the United States Geological Survey.

The secondary control work and the detailed mapping should be pushed in those portions of the State where the primary control will admit of the same. The demands for topographic work made upon the United States Geological Survey by the several states co-operating is increasing very rapidly, while Congress does not seem to be able to meet the demands; consequently, there is a tendency to decrease the amount of co-operative topographic work, notwithstanding the paramount importance of the same in the eastern portion of the United States. We should, in Pennsylvania, have sufficient appropriations that we can meet the utmost amount the United States Geological Survey is willing to allot to this State, and your Commission feels it should be able to allot to this work not less than \$15,000 per annum for each of the next two years, to be met with an equal amount by the United States Geological Survey.

The position of the National Survey regarding work in the eastern portion of the United States and in Pennsylvania has been referred to on an earlier page, and no further statement is needed to show that but very little can be expected from that organization in the way of geological work within the State.

The relative position of Pennsylvania as regards work by the State in the interests of its mineral products has also been given and the crying need of a greater amount of work cannot but be apparent to all. That the mineral products of the State, which constitute the basis for the unequalled progress made, demands very greatly increased appropriations that they be maintained in their relative position and thus continue to give to Pennsylvania its commanding position, is apparent to all.

Your Commissioners therefore recommend:

That appropriations be made commensurate with the needs of the work:

First: To extend the primary control for topographic work and the detailed mapping to meet the greatest amount the United States Geological Survey will allot to such work in this State.

Second: To enable your Commissioners to inaugurate full and comprehensive plans for geological work, that the work may be done with the detail and care necessary to conserve to the people of the State its vast mineral wealth; to encourage the development of other and new mineral industries within the State; to foster and encourage the saving of waste products and the stopping of wasteful methods in use, and generally to increase the economic value of the mineral industry of Pennsylvania.

Third: That for these purposes there be an appropriation made of not less than \$40,000 per annum for each of the next two years for the work authorized to be done by this Commission.

APPENDIX A.

LEGISLATIVE ACTS AND CONTRACTS.

AN ACT

Authorizing the Topographic and Geological Survey Commission of Pennsylvania to establish and maintain a topographic and geological survey of the State; fixing salaries; providing for the printing and binding of the results of said survey, and furnishing of supplies and stationery; and making an appropriation therefor.

Section 1. Be it enacted, etc., That the Topographic and Geological Survey Commission of Pennsylvania is hereby authorized to establish and maintain a topographic and geological survey of the State.

Section 2. The objects of such survey shall be as follows: The preparation and completion of a topographic map or maps of the State; also the study of its geological formations with special reference to the economic development of its resources, such as coal, ores, oil, gas, stones, cement material and all other minerals. With these ends in view, the said commission may, and is hereby authorized, to arrange with the United States Geological Survey, or such other National organization as may be authorized to do such work for its co-operation: Provided, That the amount of money to be expended in such co-operative work on behalf of the State shall not exceed the amount so expended by such National organization. The preparation of reports, with the necessary geological and other maps to properly illustrate the same, which shall be of such detail, character, and style of publication as the said Commission may deem best suited to properly describe the resources of the State.

Section 3. The reports of the said survey shall be printed by the Department of Printing and Binding, in such form and style as may be designated by the Topographic and Geologic Survey Commission.

Section 4. The said Commission shall serve without pay, except the chairman of the same. He shall receive a salary of not more than fifteen hundred dollars per annum; and the necessary expenses of the said Commission shall be paid out of the State Treasury, after the same shall have been submitted in itemized form to the Auditor General and approved by him.

Section 5. The said Commission shall appoint a State Geologist, who shall be in immediate charge of the work of said survey, subject to the regulations and orders of said Commission. The said geologist

shall receive a salary not to exceed three thousand dollars per annum. He may also appoint such assistants as in the judgment of such Commission may be proper and necessary.

Section 6. In addition to the reports hereinbefore authorized, the said Commission shall make a biennial report to the Governor and the Legislature, showing the progress and condition of the work, together with such other information and recommendations as the said Commission may deem necessary and useful.

Section 7. All specimens and material collected shall, after serving the purpose of the survey, be deposited in the State Museum, and there preserved in such form as to be available for study in the further work of the survey, or by individual students; but must not be removed from said museum except for study and use by the State Geologist or those working under his directions.

Section 8. All supplies and stationery, blank books, forms, or other printed matter necessary for the use of said survey, shall be furnished by the Department of Printing and Binding or the Department of Public Grounds and Buildings, upon the requisition of said Commission.

Section 9. It shall be lawful for any and all persons employed in carrying on the work of the said survey to enter upon and cross all lands within the State; Provided, That in so doing no damage shall be done to private property.

Section 10. The sum of twenty thousand dollars annually, for the term of two years, is hereby appropriated for the use of said Commission in carrying on the work authorized by this act.

Section 11. This act shall be in effect on the first day of June, Anno Domini nineteen hundred and nine.

Section 12. All laws or parts of laws inconsistent with this act are hereby repealed.

Approved—The thirteenth day of May, Anno Domini one thousand nine hundred and nine, in the sum of \$10,000 annually for the term of two years. I withhold my approval from the remainder of said appropriation because of insufficient State revenue.

EDWIN S. STUART.

AGREEMENT.

BETWEEN THE TOPOGRAPHICAL AND GEOLOGICAL SURVEY COMMISSION OF THE STATE OF PENNSYLVANIA AND THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY, FOR THE CO-OPERATIVE TOPOGRAPHIC AND GEOLOGIC SURVEY OF THE STATE.

1. The preparation of the maps shall be under the supervision of the Director of the United States Geological Survey, who shall determine the methods of survey and map construction, in accordance with the act of Assembly of the State of Pennsylvania, entitled "An act to authorize the topographic and geologic survey of the State in co-operation with the United States Geological Survey," approved April 28, 1899.

2. The order in which in point of priority different parts of the State shall be surveyed shall be agreed upon in detail between said Commission and said Director.

3. The work shall be based upon the triangulation of the United States Coast and Geodetic Survey, and, wherever this triangulation is deficient, it shall be supplemented by said co-operative survey.

4. The survey shall be executed in a manner sufficiently elaborate to prepare a topographic map upon the scale of 1:62,500 exhibiting the hydrography, hypsography and the public culture; said survey and map shall accurately show all township and county boundary lines (as established by the State laws at the time of their completion), and extensive wooded areas in this State as existing on the ground at the time of the execution of these surveys; the location of all roads, railroads, streams, canals, lakes, and rivers, and shall show by contour lines the elevation and depression of the surface of the country, also on geologic maps and the location of the coal, oil, natural gas, clay-bearing and other geological formations. The said topographic maps shall be similar to the sheets already completed in this State, and the form of the final publications of the geological maps shall be the same as the Geological Atlas of the United States Geological Survey.

The primary field maps shall be on such a scale as said Director shall select to secure accuracy in the construction of the final map.

5. It is understood and agreed upon that the geological work shall follow the topographic survey as closely as consistent with economy and in accordance with modern scientific methods. The time of beginning this work to be agreed upon between the State Survey Commission of Pennsylvania and the United States Geological Survey.

6. The hypsography shall be shown by contour lines with vertical intervals of 20 feet, and the heights of important points shall be determined and marked upon fixed and permanent bench marks in impor

tant and prominent places throughout the counties; also correct meridian points shall be located at each county seat and records furnished to the said Commission.

7. For convenience, the United States Geological Survey shall, during the progress of the field work, pay the salaries of the persons employed therein, while the traveling, subsistence and field expenses shall be paid for the same by the State. For office work on the map the salaries shall be divided between the two agreeing parties in such a way as to equalize all expenses, provided that the total cost to the State of Pennsylvania of the field and office work and expense of said Commission for the year 1899 and 1900 shall not be more than forty thousand dollars (\$40,000), and provided that the United States Geological Survey shall expend an equal amount.

8. During the progress of the work free access to the field sheets and records of the topographers and draughtsmen shall be afforded the State Commissioners for examination and criticism; and should they deem that the work is not being executed in accordance with this agreement, then the said Commissioners may, on formal notice, terminate this agreement.

9. The resulting maps shall fully recognize the co-operation of the State of Pennsylvania.

10. As the work is completed, the State Commission shall be furnished by the United States Geological Survey with photographic copies of the manuscript sheets; and, when the engraving, which is to be done at the cost of the United States Geological Survey, is completed, and at all times thereafter, when desired, the said Commission shall be furnished by the said Survey with transfers at cost of printing from the copper plates of the photographic sheets for use in printing editions of said maps.

Washington, D. C., July 12, 1899.

(Signed)

CHAS. D. WALCOTT,
Director U. S. Geological Survey.

G. W. McNEES,
SIMON HARROLD,
FRED. D. BARKER,
Topographic Survey Commissioners.

APPENDIX B.

TRIANGULATION AND PRIMARY TRAVERSE.

The descriptions and positions published herewith are the result of the field work of the season of 1908-09.

PENNSYLVANIA-MARYLAND.

TRIANGULATION STATIONS.

BERLIN, CONFLUENCE, HYNDMAN AND MEYERSDALE QUADRANGLES, PENNA. BEDFORD, FAYETTE AND SOMERSET COUNTIES.

ACCIDENT, FROSTBURG AND GRANTSDALE QUADRANGLES, MD. ALLEGHENY AND GARRETT COUNTIES.

During the season of 1908, Geo. T. Hawkins extended triangulation control over the four quadrangles in Pennsylvania mentioned above, from stations Meadow and Sampson, which are situated in Maryland just south of the Pennsylvania line. In addition to the reoccupation of these two old stations, 11 new stations were occupied and two points were located by intersections. Positions are given on United States standard datum.

MEADOW 2, GARRETT COUNTY, MARYLAND.

On the highest part of Meadow Mountain, about twelve miles northwest of Frostburg and one mile north of New Germany post office. The summit was cleared of timber with the exception of one tree, which was trimmed up and left for a signal.

Signal: Trimmed tree, only one on summit.

Reference mark: Copper bolt cemented in solid rock, distant from signal tree 15 feet, azimuth from signal tree $346^{\circ} 43'$.

Station mark: Signal tree.

(Latitude $39^{\circ} 39' 16.25''$. Longitude $79^{\circ} 06' 20.15''$.)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Accident, -----	78 43 55.90	258 36 42.49	4.2180560
Negro, -----	134 05 59.85	314 02 20.27	4.0570135
Sampson, -----	248 27 35.75	68 34 20.31	4.2102258
Dan, -----	294 15 18.02	114 23 15.43	4.2921905
High Rook, -----	356 34 45.72	176 35 05.20	4.0873862
Peck, -----	160 29 14.36	340 26 42.26	4.2291922
Bear, -----	212 13 55.77	32 19 34.37	4.3731153

RICH, GARRETT COUNTY, MARYLAND.

On Rich Ridge on land owned by Mr. Si Turney about 0.75 mile southwest of the "State Line" Hotel at Strawn post office and three miles southeast of Addison, Pennsylvania. Is in clear field near woods on south side of field, which is on top of hill.

Signal: White flag in top of locust tree.

Station mark: An aluminum tablet cemented in large boulder, 22.5 feet northwest of signal.

(Latitude $39^{\circ} 42' 35.15''$. Longitude $79^{\circ} 18' 40.14''$.)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Shipley, -----	138 05 55	318 00 53	4.22561
Steyer, -----	104 45 31	344 42 34	4.39096
Peck, -----	230 29 07	50 34 28	4.18980

SAMPSON, ALLEGHENY COUNTY, MARYLAND.

On a high point of Savage Mountain, about seven miles north of Frostburg, about 100 feet east of "Sampson Rock." The timber is low on the top of the mountain, the backbone of the ridge being rocky.

Station mark: Bronze tablet cemented in solid rock.

(Latitude $39^{\circ} 42' 28.94''$. Longitude $78^{\circ} 55' 46.56''$.)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Evitts, -----	268 19 36.78	88 29 45.78	4.3562909
Warrior, -----	289 54 51.30	110 06 41.28	4.4505251
Dan, -----	348 54 39.03	168 55 52.46	4.1547327
Meadow (2), -----	68 34 20.31	248 27 35.75	4.2102258
Negro, -----	94 58 04.81	274 47 40.23	4.3685514
Peck, -----	115 52 54.69	295 43 37.31	4.3626170
Bear, -----	169 59 49.52	349 58 42.99	4.1533913

HYNDMAN, BEDFORD COUNTY, PENNSYLVANIA.

On highest point on Mill Creek Mountain about three miles north-east of Hyndman, Pennsylvania. To reach station from Hyndman follow mail trail to top of mountain, thence northwards on top and follow blazed trail to point. Lines of sight chopped out to other points.

Signal: White flag in 6-inch chestnut tree.

Station mark: An aluminum tablet in solid rock 6.5 feet west of signal tree.

(Latitude 39° 50' 45.46". Longitude 78° 40' 56.53".)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Bear, -----	86 57 21	266 46 44	4.37418
Hostetter, -----	117 08 22	297 01 15	4.24963
Wills, -----	215 56 47	35 59 01	3.92752
Martin, -----	266 28 17	86 32 28	3.96968

MARTIN, BEDFORD COUNTY, PENNSYLVANIA.

Martin Mountain is in Cumberland Township on Pennsylvania Forest Reserve, about three miles southwest of Rainsburg and about 1.5 miles nearly south of D. N. Rawlings' house.

Signal: Flag in tree on west slope of mountain.

Station mark: Aluminum tablet cemented in rock 9 feet square and 3 feet high.

(Latitude 39° 51' 03.88". Longitude 78° 34' 25.00".)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Hyndman, -----	86 32 28	266 28 17	3.96968
Wills, -----	145 24 37	325 22 40	3.88261

WILLS, BEDFORD COUNTY, PENNSYLVANIA.

A peak on the Wills Mountain about 2 miles southwest from Buffalo Mills and about 200 yards north of where the road crosses Wills Mountain, which is known as Valley Crossing of Wills Mountain.

Signal: White flag on trimmed red oak tree 8 inches in diameter, distance from station 15.8 feet and azimuth from station mark is $54^{\circ} 21'$.

Station mark: An aluminum tablet cemented in solid rock 15.8 feet northeast of tree.

(Latitude $39^{\circ} 54' 27.54''$. Longitude $78^{\circ} 37' 27.40''$.)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Hyndman, -----	35 59 01	215 56 47	3.92752
Savage, -----	90 50 23	270 43 41	4.16345
Hostetter, -----	93 30 12	273 20 50	4.31866
Martin, -----	325 22 40	145 24 37	3.88261

SHIPLEY, FAYETTE COUNTY, PENNSYLVANIA.

On a gravel ridge about 5 miles northwest of Confluence on top of cleared hill which has a few trees on summit and is about 200 yards west of Mr. Shipley's house.

Signal: White flag in top of locust tree 10 inches in diameter.

Station mark: An aluminum tablet cemented in solid rock 42.5 feet northeast of signal tree, azimuth $225^{\circ} 01'$.

(Latitude $39^{\circ} 49' 20.60''$. Longitude $79^{\circ} 26' 32.24''$.)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Peck, -----	276 28 16	96 38 40	4.36779
Rich, -----	318 00 53	138 05 55	4.22561

STEYER, NEAR COUNTY LINE—SOMESSET AND FAYETTE—PENNA.

In an old field on south end of ridge on Laurel Mountain on land owned by Miss Sarah Steyer, 9 miles north of Confluence, 5 miles southwest of Scullton post office and 0.5 mile west of sawmill.

Signal: Tripod made of sawed lumber.

Station mark: Aluminum tablet in sandstone 30 by 8 by 12 inches.

Instrument on center.

(Latitude $39^{\circ} 55' 35.37''$. Longitude $79^{\circ} 23' 16.28''$.)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Somerset, -----	250 36 04	70 48 16	4.44745
Berlin, -----	265 20 48.11	85 35 23.72	4.5116915
Bear, -----	285 26 00.13	105 42 31.22	4.5812618
Peck, -----	307 29 21.94	127 37 40.69	4.3679374
Rich, -----	344 42 34	164 45 31	4.30696

BEAR, SOMERSET COUNTY, PENNSYLVANIA.

On a high part of the main Allegheny ridge on land owned by P. D. Bear and about 0.75 mile east of his house. Top is heavily timbered and is about 5 miles northeast of Meyersdale and 2.5 miles from Sandpatch.

Signal: A red and white target fastened to corner of platform, which is built of sawed lumber, having for two of its legs red oak trees. Instrument elevated about 50 feet.

Station mark: Bronze tablet in rock under center of platform.

(Latitude $39^{\circ} 50' 03.51''$. Longitude $78^{\circ} 57' 30.56''$.)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Meadow, -----	32 19 34.37	212 13 55.77	4.3731153
Peck, -----	77 44 58.30	257 36 46.80	4.2715364
Steyer, -----	105 42 31.22	285 26 00.13	4.5812618
Berlin, -----	161 22 35.82	341 20 39.26	4.1306763
Hostetter, -----	219 39 11	39 42 41	4.08629
Savage, -----	239 10 27	59 16 45	4.21241
Hyndman, -----	266 46 44	86 57 21	4.37418
Sampson, -----	349 58 42.99	169 59 49.52	4.1533913

BERLIN, SOMERSET COUNTY, PENNSYLVANIA.

On top of partly cleared hill on land owned by Corneal Cover and 300 yards southwest of his house on line with rail fence. Is about 3 miles nearly west of Berlin and about 6 miles southeast of Somerset.

Signal: Flag in top of trimmed wild cherry tree, which is about 0.5 mile south of road between Somerset and Berlin.

Station mark: An aluminum tablet in top of marble post 26 by 6 by 6 inches set in ground 20 inches.

(Latitude 39° 56' 58.59". Longitude 79° 00' 32.31".)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Peck, -----	39 43 09.13	219 36 53.56	4.3386610
Steyer, -----	85 35 23.72	265 20 48.11	4.5116915
Somerset, -----	138 29 24	318 26 44	3.95116
Highland, -----	149 45 31	329 42 47	4.07933
Hostetter, -----	285 42 59	105 48 26	4.09935
Bear, -----	341 20 39.26	161 22 35.82	4.1306763

HIGHLAND, SOMERSET COUNTY, PENNSYLVANIA.

On knob in orchard owned by Mr. Peter Haffley and 500 feet north of his house, 2 miles north of Somerset.

Signal: Double tripod made of sawed lumber. Instrument elevated 20 feet.

Station mark: Marble post 30 by 6 by 6 inches set in ground 28 inches.

(Latitude 40° 02' 34.78". Longitude 79° 04' 47.34".)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Peck, -----	16 09 50	196 06 18	4.45134
Berlin, -----	329 42 47	149 45 31	4.07933
Somerset, -----	358 01 40	178 01 40	3.56597

HOSTETTER, SOMERSET COUNTY, PENNSYLVANIA.

On main ridge of Allegheny Mountain, about 5 miles nearly east of Berlin, 0.25 mile east of Mud Pike on land owned by Mr. Hostetter, and 0.25 mile northeast of his house.

Signal: On tripod above instrument support, which is 18 feet in height and upon which the theodolite was supported. Is built of sawed timber and guyed with four wires.

Station mark: Aluminum tablet in center of top of a sandstone post 30 by 10 by 8 inches and set in ground 26 inches under center of signal.

(Latitude $39^{\circ} 55' 07.88''$. Longitude $78^{\circ} 52' 02.80''$.)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Bear, -----	39 42 41	219 39 11	4.08629
Berlin, -----	105 48 26	285 42 59	4.09935
Wills, -----	273 20 50	93 30 12	4.31866
Savage, -----	279 30 14	99 33 02	3.79992
Hyndman, -----	297 01 15	117 08 22	4.24993

PECK, SOMERSET COUNTY, PENNSYLVANIA.

On the Negro Mountain, about 10 miles west of Meyersdale, on land owned by a coal company 0.5 mile north of where road from Meyersdale to Confluence crosses the mountain and 1.5 miles northeast of Mr. Howard Peck's house. Is timbered and flat on top, and lines of sight have been chopped out to other points.

Signal: A white flag in top of 15-inch pine tree.

Station mark: Bronze "Penna." tablet in large rock, 12 feet east of signal tree. The plate is not on highest part as there was no high tree for signal on highest part about 100 feet southwest of highest part.

Instrument elevated 22 feet.

(Latitude $39^{\circ} 47' 54.24''$. Longitude $79^{\circ} 10' 18.14''$.)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Rich, -----	50 34 28	230 29 07	4.18980
Shipley, -----	96 38 40	276 28 16	4.36779
Steyer, -----	127 37 40.69	307 29 21.94	4.3679374
Highland, -----	196 06 18	16 09 50	4.45184
Somerset, -----	198 45 42	18 49 18	4.39447
Berlin, -----	219 36 53.56	39 43 09.13	4.3386610
Bear, -----	257 36 46.80	77 44 58.30	4.2715364
Sampson, -----	295 43 37.31	115 52 54.69	4.3626170
Meadow, -----	340 26 42.26	160 29 14.36	4.2291922

SAVAGE, SOMERSET COUNTY, PENNSYLVANIA.
(Not Occupied.)

On land owned by Mr. Hubbard in Somerset county, Pa. The point sighted is the most southerly of three tall locust trees which stand in cleared field west of Mr. Hubbard's house, which is about 0.5 mile west of Glen Savage post office.

(Latitude 39° 54' 34.04". Longitude 78° 47' 40.91".)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Bear, -----	59 16 45	239 10 27	4.21241
Hostetter, -----	99 33 02	279 50 14	3.79902
Wills, -----	270 43 41	90 50 23	4.16345

SOMERSET, SOMERSET COUNTY, PENNSYLVANIA.
(Not Occupied.)

In Somerset county, in town of Somerset, dome of the County Courthouse.

Signal: Center of Dome.

Station mark: Center of Dome.

(Latitude 40° 00' 35.54". Longitude 79° 04' 41.92".)

Station.	Azimuth.	Back Azimuth.	Log. Dist.
	° ' "	° ' "	Meters.
Peck, -----	18 49 18	198 45 42	4.39447
Steyer, -----	70 48 16	250 36 04	4.44745
Highland, -----	178 01 40	358 01 40	3.56597
Berlin, -----	318 26 44	138 29 24	3.95116

PRIMARY TRAVERSE.

BUTLER, FRANKLIN, HILLIARDS, MERCER, OIL CITY, STONEBORO
AND TOWNVILLE QUADRANGLES.

BUTLER, MERCER AND VENANGO COUNTIES.

The following geographic positions on United States standard datum were determined from primary traverse run by C. B. Kendall in the spring of 1908. The lines were run as follows: Beginning with adjusted position of Primary Traverse Station No. 2 at Mercer (Ellis), the line follows east along latitude $41^{\circ} 15'$ via Millbrook, Bullion, Cyrus and Pittsville to Beel's triangulation station. Line No. 2 begins at Pittsville and follows highways north to East Sandy, thence along the Pennsylvania Railroad, via Franklin, to Reno, where it crosses the Allegheny river and continues north along highways to the northeast corner of the Franklin quadrangle, thence west via Dempseytown and Cooperstown to Carlton, thence west via Milledgeville to Boutner Schoolhouse, and is tied to adjusted position (Ellis). Line No. 3 begins at Carlton and follows highways south via Reed's Furnace to the southeast corner of the Stoneboro quadrangle. Line No. 4 begins at the southeast corner of the Stoneboro quadrangle and follows highways south via Harrisville, Keister and Stone House to Primary Traverse Station No. 2, 1906, at Elora (Kendall). Line No. 5 begins with adjusted position of Primary Traverse Station No. 4, 1906, near Karn's City (Kendall), and follows highways north via North Washington, Shira, Eau Clair, Suttons Mills and Big Bend to Cyrus and is tied to line No. 1. In the spring of 1909 east and west lines were run by Mr. Kendall through the centers of the Franklin and Stoneboro quadrangles.

STONEBORO QUADRANGLE.

Geographic positions along highways along north and east borders of quadrangle.

Stations.	Latitude.	Longitude.
	° ' "	° ' "
Boutner Schoolhouse, T road south at; 21 feet north to cross on board-fence, 35 feet southwest to guide post, -----	41 29 32.5	80 13 08.2
Boutner Schoolhouse, 1 mile east and 0.5 mile south of; crossroads, 30 feet southwest to telephone pole, 70 feet northwest to large chestnut stump, -----	41 29 04.7	80 11 52.4
Crossing of the Mercer-Meadville pike and the Crawford-Mercer county line road, 40 feet southwest to stone at corner of fence, 25 feet northwest to corner of wire fence, -----	41 28 55.0	80 11 07.0
T road north, 10 feet north to center of triangle, 30 feet northwest to guide board "Meadville 12 mi.," -----	41 28 51.2	80 09 01.2
Sunol, 0.5 mile northeast of, crossroads; 45 feet southeast to corner of building, 25 feet northeast to guide board "Turnpike 2 miles-Meadville 12 miles," -----	41 28 50.5	80 08 22.6

STONEBORO QUADRANGLE—Continued.

Stations.	Latitude.	Longitude.
Milledgeville, 3 miles west and 1 mile north of, on west edge of the New Vernon-Cochran road, at T road east along the Mercer-Crawford County Line; iron post stamped "Prim. Trav. Sta. No. 9—PENNSYLVANIA 1908,"	41 29 12.1	80 06 53.7
Centre of T road east on Mercer-Crawford County Line; 20 feet east to mail box in centre of triangle,	41 29 12.1	80 06 53.5
Milledgeville, 1.33 miles west and 1.2 miles north of; T road south; 25 feet north to small apple tree, 30 feet northwest to guide board "Cochran 4 miles—Mercer Pike 5 miles—New Lebanon 5 miles—Meadville 12 miles," 60 feet west to T road north,	41 29 14.8	80 05 18.8
Milledgeville, 1.25 miles north of on Mercer-Crawford County Line; centre of crossroads; 25 feet southwest to telephone pole, 30 feet northwest to oak tree and guideboard "Cochran 3 miles—Milledgeville 1 mile—Mercer Pike 6 miles,"	41 29 17.3	80 03 44.3
Carlton, 1.25 miles northwest of, T road east of County Line, large oak in centre of triangle,	41 29 22.2	80 01 18.1
Carlton, 75 feet northwest of station, highway bridge over French Creek, 90 feet north of road crossing the Erie Railroad, centre of track at,	41 28 20.0	80 01 05.4
Milledgeville, 300 feet southwest of schoolhouse; crossroads; 40 feet southwest to corner of old store, 40 feet northeast to telephone pole, 40 feet northeast to guidepost "New Lebanon 4 miles—Cochran 4 miles—Sheakleyville 8 miles—Carlton 3 miles,"	41 28 13.5	80 03 46.5
Carlton, 1 mile west of, T road north; 40 feet northeast to large cherry tree, 20 feet south to maple tree,	41 28 05.4	80 02 09.8
Carlton, 0.5 mile southwest of, T road west, 20 feet southwest to large apple tree in triangle, 30 feet northwest to large maple tree,	41 28 03.3	80 01 13.9
Schoolhouse No. 6; crossroads at; 25 feet southwest to telephone pole, 25 feet northeast to guidepost "Milledgeville 3 miles—Utica 3 miles—North Sandy 4 miles—Carlton 2 miles,"	41 26 39.1	80 00 45.0
Utica, 3 miles west of, crossroads, 35 feet northwest to telephone pole, 25 feet southwest to guidepost "Utica 3 miles—New Lebanon 4 miles,"	41 25 53.1	80 00 45.6
Mill Creek Bridge, 300 feet south of, crossroads, 200 feet southwest to schoolhouse, 45 feet southeast to cherry tree, 50 feet northeast to telephone pole,	41 25 26.4	80 00 21.0
Mill Creek, 1 mile south of, crossroads at windmill, 60 feet to southeast corner of windmill, 25 feet southeast to guidepost "Carlton 4 miles—Sandy Lake 5 miles—Utica 3.5 miles,"	41 24 34.6	80 00 29.9
Old Store, crossroads at, 35 feet north to corner of store, 35 feet to telephone pole,	41 24 19.4	80 01 11.6
White Schoolhouse, 150 feet northwest of, crossroads; 45 feet southeast to large oak tree and guideboard "Utica 7 miles—Sandy Lake 4 miles—" 30 feet northwest to oak tree,	41 23 12.1	80 01 08.6
Watering Trough; crossroads at, 35 feet southeast to guideboard at trough, "Five Points 3 miles—Reeds Furnace 2 miles—Sandy Lake 4 miles—Franklin 12 miles," 35 feet southwest to corner of rail fence,	41 22 20.3	80 01 06.0
Reeds Furnace, 1.5 miles north of, in the southeast corner of intersection of the Polk-Sandy Lake road and the Carlton-Reeds Furnace road, 4 miles west to Sandy Lake, 5 miles east to Polk, 0.4 mile north to schoolhouse No. 1, beside guidepost: iron post stamped "Prim. Trav. Sta. No. 10—PENNSYLVANIA 1908,"	41 21 33.0	80 01 04.0
Reeds Furnace, 1.0 mile north of, crossroads; 30 feet southwest to guide board at maple tree "Five Points 4 miles—Reeds Furnace 1 mile—Franklin 11 miles—Polk 5 miles—Sandy Lake 4 miles,"	41 20 52.0	80 01 03.0
Lake Shore and Michigan Southern Railroad crossing over centre of public road,	41 20 02.7	80 00 18.7
Centre of triangle at four-corners, public road west, second class road east; 25 feet north to maple tree, 45 feet southwest to apple tree,	41 19 19.3	80 00 46.0
Reeds Furnace, 2 miles south of, T road north, 15 feet north to two plank bridge, 35 feet northeast to telephone pole and guideboard "Reeds Furnace 2 miles,"	41 18 30.5	80 00 49.0
Henderson, 0.8 mile east of, public roads west and southwest, centre of triangle at; 30 feet east to guide board "Taylor road 1 mile,"	41 18 21.7	80 01 22.6
Henderson, 1 mile southeast of; T road north; 10 feet north to centre of triangle, 35 feet northeast to guide board "Henderson 1 mile—Franklin road 1 mile,"	41 17 30.4	80 01 24.4
Forks of public road to south and southeast; 25 feet southeast to centre of triangle, 25 feet southwest to guide board "Freeport road 1 mile,"	41 17 08.9	80 00 40.7

Magnetic Declination of East border of quadrangle is 3° 34' west.

Magnetic Declination of North border of quadrangle is 3° 41' west.

STONEBORO QUADRANGLE—Continued.

Geographic positions along highways east and west through centre of quadrangle.

Stations.	Latitude.	Longitude.
	° ' "	° ' "
Schoolhouse, T road south 150 feet north of; 30 feet southwest to J. A. Bond's mail box, 40 feet northeast to oak near fence line, ---	41 20 51.3	80 01 44.9
T road north, centre of east and west road at; 20 feet north to centre of triangle, -----	41 20 53.8	80 02 26.3
T road north, centre of east and west road at, 20 feet north to centre of triangle, 20 feet northwest to sign "Milledgeville 9 miles,"	41 20 50.0	80 03 01.6
Iron bridge over small stream, centre of, near T road, -----	41 20 53.9	80 03 31.0
Sandy Lake, crossing Lake Shore Railway and Main Street at, 500 feet east of station, -----	41 20 55.1	80 04 56.1
Stoneboro, 500 feet east of station, crossing Lake Shore Railway and Main Street at, -----	41 20 31.8	80 06 19.6
Stoneboro, at northeast corner of Lake and Walnut Streets, in foundation stone 1.7 feet above step at left side of entrance to First National Bank; aluminum tablet stamped "Prim. Trav. Sta. No. 2—PENNSYLVANIA—1909," -----	41 20 20.9	80 06 25.0
Stoneboro, 1.5 miles west of, crossing of Lake Shore Railway, -----	41 20 53.2	80 07 46.9
T road north, centre of east and west road at, 10 feet north to centre of triangle, -----	41 21 06.0	80 08 26.2
Coulson, 0.5 miles west of, Four-corners; 10 feet north to centre of triangle, 25 feet northwest to fence post painted "1230," -----	41 21 05.5	80 09 13.8
Coulson, 2.0 miles west of, crossroads; 20 feet north to Jno. E. Vernon's mailbox, 35 feet northwest to sign "Clarks Mill 3 miles—Mercer 10 miles—Stoneboro 3 miles," -----	41 21 03.2	80 10 31.3
Store and schoolhouse, 25 feet northwest to sign "Stoneboro 5 miles—Greenville 11 miles—Clarks Mill 4.5 miles—Mercer 8.5 miles," 25 feet east to telephone pole; four-corners at, -----	41 20 59.8	80 12 27.1
Pittsburg and Erie Pike and District Line road, crossing of; 20 feet northwest to sign "Sandy Lake 8 miles—Greenville 10 miles—Mercer 8.5 miles," 20 feet south to small bridge, 28 feet east to small bridge, -----	41 20 58.1	80 13 30.9
St. Paul Schoolhouse, 300 feet east of, centre of crossroads, -----	41 15 00.1	80 01 14.3
T road north; 5 feet north to centre of triangle, 30 feet northeast to guide board "Kilgore 1 mile," -----	41 15 01.1	80 00 17.7

FRANKLIN QUADRANGLE.

Geographic positions along highways near west border of quadrangle.

Stations.	Latitude.	Longitude.
	° ' "	° ' "
Mercer-Venango County Line, large elm tree on south side of road, 870 feet west of T road north, -----	41 16 55.4	79 59 56.9
Barn, T road east at; 5 feet east to centre of triangle, 20 feet north-east to sign, -----	41 16 13.2	79 59 38.2
Crossroads, 10 feet south to small bridge, 20 feet northeast to guide board "Sandy Lake 9 miles—Mechanicsville 3.5 miles—Ray Milton 6 miles—Mercer Road 1.5 miles," -----	41 15 31.7	79 59 29.7
Mechanicsville, 1.5 miles northwest of, T road southwest at brick house; centre of triangle at, -----	41 15 08.8	79 58 19.4
Millbrook, 4 miles east of, south edge of Millbrook-Kumerdell road, opposite junction with T road north; 1.5 miles northeast to Kilgore, 500 feet west to T road south; iron post stamped "Prim. Trav. Sta. No. 2—PENNSYLVANIA 1908," -----	41 15 02.0	79 59 28.5

Magnetic Declination of West border of quadrangle is 3° 34' west.
Magnetic Declination of South border of quadrangle is 4° 40' west.

TOPOGRAPHIC AND GEOLOGIC SURVEY.

FRANKLIN QUADRANGLE—Continued.

Geographic positions along highways.

Stations.	Latitude.	Longitude.
	° ' "	° ' "
St. George, 1.5 miles east of, public crossroads, 25 feet northwest to post, 30 feet southeast to two mail boxes, -----	41 15 12.5	79 46 14.8
Pittsville, 1.5 miles west of, 4-corners, public road south, second class road north, 10 feet south to a three-plank bridge, -----	41 15 05.3	79 45 24.4
Floyd Post-office, 1.0 mile southeast of, T road to northeast, 35 feet north to sign "Franklin road 1 mile," 25 feet south to rail fence, -----	41 17 41.5	79 45 27.0
Floyd Post-office, crossroads at; 15 feet south to telephone pole, 30 feet north to telephone pole and sign "E. Sandy 3 miles—Scrub-grass 5 miles—Brandon's Ferry 5 miles—Davis' Corners 2.5 miles;" -----	41 17 57.6	79 46 22.4
East Sandy, 1.0 mile south of, second class east and west road, 25 feet east to leaning oak tree, 80 feet northwest to corner of old log stable, 75 feet east to corner of buggy house, -----	41 19 08.6	79 46 18.0

Geographic Positions along Pennsylvania R. R.

East Sandy Station, 650 feet north of, in coping of west wing wall to south abutment of Penna. R. R. two-span bridge over Sandy Creek; bronze tablet stamped "970—PITTSBURG," -----	41 19 57.6	79 46 08.0
Astral station, road crossing 70 feet south of station board, centre of track at, -----	41 20 37.2	79 46 21.4
Milepost 12, centre of track opposite, -----	41 21 01.0	79 47 14.6
Yard Limit sign, 75 feet south of, centre of track opposite a second class road leading up hill to northeast, 50 feet east to small house, 30 feet north to oil well, -----	41 21 48.7	79 47 15.2
Highway and Electric Railroad bridge over Allegheny River, 1.0 mile southeast of Franklin, centre of Pennsylvania Railroad main track at road crossing, at north end of bridge, -----	41 22 31.2	79 48 46.6
Franklin, Pennsylvania Railroad freight and passenger stations, 100 feet northwest of the northwest corner of, on bank of Allegheny River, 68 feet west of centre of main track, 40 feet southeast of south end of shore pier to highway bridge over river; iron post stamped "PRIM. TRAV. STA. No. 5—PENNSYLVANIA," -----	41 23 23.0	79 49 05.6
Prentice station board, 120 feet northeast of, south rail of main track at road crossing, -----	41 24 32.2	79 47 18.9
Milepost 5, centre of track opposite, -----	41 24 48.7	79 46 08.9

Geographic position along highways.

Reno, T road to north, 350 feet south of Electric Street Railway, 50 feet north to corner of front yard fence, 50 feet northeast to same, -----	41 24 41.8	79 45 20.9
Hazleton Schoolhouse, 200 feet southeast of, T road west; 25 feet east to oak, 30 feet southwest to Heary and sign "Cooperstown 2.5 miles—Sunville 3 miles," -----	41 29 45.7	79 49 32.0
Cooperstown, 1.25 miles east of, second class T road southwest, centre of east and west road at, -----	41 29 53.1	79 50 33.1
Cooperstown, 2.0 miles west of, crossroads; 25 feet southwest to sign "Cochranton 8 miles—Cooperstown 2 miles—Sugar Creek 5 miles—Donation 2 miles," 15 feet north to small drain, -----	41 29 44.3	79 54 08.4
Carlton, 1.5 miles northeast of, public crossroads, 30 feet northwest to large chestnut tree, 30 feet southeast to sign "Turnpike Road 1 mile—Cochranton 4 miles," -----	41 29 25.5	79 50 38.3

Along highways east and west through centre of quadrangle.

Franklin, city monument in centre of street car track, at crossing of 13th and Elk streets, -----	41 23 56.9	79 49 53.4
Franklin, 1.5 miles west of, small apple tree in centre of triangle at forks on top of hill, -----	41 23 13.4	79 50 55.3
Franklin, 2.5 miles west of, T road north; 35 feet northeast to sign-post, 110 feet west to T road south, -----	41 22 59.1	79 52 08.3
Blacks Schoolhouse, 4-corners at, 15 feet west to telephone pole painted "1508," -----	41 22 45.0	79 53 17.8

FRANKLIN QUADRANGLE—Continued.

Stations.	Latitude.	Longitude.
	° ' "	° ' "
T road north, 15 feet north to small bridge, 25 feet southwest to telephone pole painted "1091," -----	41 22 32.5	79 54 55.4
Polk, forks at north edge of, 400 feet northwest to iron bridge, 35 feet north to sign "Utica 6 miles," -----	41 22 17.1	79 55 26.7
Polk, in south face of southeast corner of administration building of State Institution for Feeble-Minded; aluminum plate stamped "Prim. Trav. Sta. No. 1-1909-PENNSYLVANIA," -----	41 22 16.8	79 55 48.7
Polk, 300 feet north of station; Lake Shore Railway at street crossing, -----	41 22 05.8	79 55 38.4
Polk, 1.5 miles southwest of, forks; 35 feet west to signpost, 25 feet northeast to small oak, -----	41 21 17.7	79 56 26.2
Bridge over small stream, 40 feet east to second class crossroad, -----	41 21 10.4	79 58 22.5
Raymilton, 1.0 mile north of, crossroads; 20 feet west to signpost "Polk 4 miles—Sandy Lake 5 miles—Raymilton 1 mile—Utica 8 miles," -----	41 21 05.0	79 59 16.0

BUTLER QUADRANGLE.

Geographic positions near north border of quadrangle.

Haysville, guidepost in centre of triangle at 3-corners; guidepost reads "Trautman 1 mile—Fairview 1 mile—Butler 14 miles," -----	40 59 53.6	79 45 21.4
Elora Grange Hall, 0.5 mile north of; crossroads; 40 feet northwest to forked maple tree, 45 feet northeast to maple at corner of front yard, -----	40 59 37.9	79 59 21.7
Elora, at junction of Butler and Mercer Pike at road leading west to West Liberty; 25 feet south of southeast corner of the Grange Hall; iron post stamped "Prim. Trav. Sta. No. 2-1906," -----	40 59 13.60	79 59 14.30

HILLIARDS QUADRANGLE.

Geographic positions along highways near west border of quadrangle.

Wesley, 1.5 miles west of, 10 feet south of east and west road and in centre of north and south road; large maple tree at four-corners, Centre of north and south road at T road west; 35 feet northwest to guide board "Grove City 5 miles," 35 feet southwest to guide board "Henderson road 1 mile," -----	41 14 06.2	79 59 32.9
Keister, 150 feet west of station, centre of north track of Bessemer railroad at pike crossing, -----	41 09 58.7	79 59 59.9
Keister, 1 mile south of, T road west; 20 feet west to centre of triangle, 30 feet east to stump, 35 feet east to telephone pole, -----	41 02 53.1	79 59 51.1
Halston, 0.5 mile west of, T road east; 35 feet west to corner of buggy house, 35 feet southeast to telephone pole, -----	41 01 57.0	79 59 52.4
	41 01 08.9	79 59 58.7

Magnetic Declination of west border of quadrangle is 4° 19' west.

Geographic positions along highways near north border of quadrangle.

Mechanicsville, 1.5 miles north of; crossroads; 30 feet southeast to oak tree, 10 feet west to a two-plank bridge, -----	41 14 49.0	79 57 37.1
Mechanicsville, 1.25 miles northeast of; centre of crossroads; 30 feet southwest to guide board "Roy Milton road 1 mile," 20 feet east to three-plank bridge, -----	41 14 38.1	79 57 00.3
Mechanicsville, 2.0 miles northeast of; centre of crossroads; 20 feet southeast to corner post of wire fence, 20 feet northeast to corner rail fence, -----	41 14 37.0	79 56 01.3
Bullion Store, T road east at; 15 feet south to small bridge, 35 feet northeast to telephone pole, -----	41 14 47.3	79 53 53.1
Bullion, 1.4 miles east of; T road south; 30 feet southeast corner fence, -----	41 14 48.6	79 52 17.3
Kennerdell, in stone coping to north wing wall at west end of highway bridge over Scrubgrass Creek; aluminum tablet stamped "Prim. Trav. Sta. No. 3 PENNSYLVANIA 1908," -----	41 14 18.0	79 51 16.0
Cyrus, 2 miles west of; large oak tree in east and west road at T road south, -----	41 14 22.8	79 49 45.2
Cyrus, crossroads at; 30 feet southwest to guide board "Kennerdell 4 miles—Emlenton 9 miles," 25 feet south to centre of bridge, -----	41 14 23.4	79 48 35.6

Magnetic Declination of north border of quadrangle is 4° 46' west.

HILLIARDS QUADRANGLE—Continued.

Geographic positions along highways near west border of quadrangle.

Stations.	Latitude.	Longitude.
	° ' "	° ' "
Schoolhouse, 300 feet northwest of; T road east, -----	41 13 12.8	79 48 07.1
Cyrus, 1.5 miles south of, 300 feet southwest of school; T road west; 30 feet northwest to guidepost "Kennerdell 3 miles—Emlenton 7 miles—Scrubgrass 5 miles, -----	41 13 07.6	79 48 04.9
Lisbon, 0.5 mile north of; R. T. Atwell's mail box at T road east, --	41 12 15.0	79 47 41.0
Lisbon Church, 125 feet southeast of; forks of road; 35 feet south- east to telephone pole, 20 feet southwest to stump, 55 feet north- west to post in angle, -----	41 11 46.2	79 47 35.5
Suttons Mill, T road southwest at; 25 feet southeast to guideboard "Eauclair 4 miles," 90 feet northeast to front door of mill, 110 feet east to west end of bridge over Little Scrubgrass Creek, -----	41 11 27.4	79 47 04.2
East Unity Church, 1,700 feet northeast of; centre of road at Butler- Venango County Line crossing; 10 feet east to small bridge, 40 feet west to stone on County Line, 15 feet south to mail box, 70 feet northwest to barn door, -----	41 10 22.9	79 47 37.9
East Unity Church, 100 feet west of; centre of triangle at forks; 30 feet southwest to guidepost "Farmington 3 miles—Clintonville 5 miles," -----	41 10 09.7	79 47 51.7
Cherry Valley Schoolhouse, crossroads at; 50 feet southwest to water- ling trough, 40 feet northwest to large oak tree; 60 feet northeast to corner of schoolhouse, -----	41 09 26.2	79 47 56.7
Farmington (Eau Clair post-office), in north face at northwest corner of foundation of A. O. Miller's store at southeast corner of Main and Washington streets; aluminum tablet stamped "Prim. Trav. Sta. No. 12—PENNSYLVANIA 1908," -----	41 08 10.0	79 47 54.6
Farmington (Eau Clair post-office), centre of intersection of Main and Washington streets at; 40 feet northeast to corner of store, 35 feet northwest to corner of hotel porch, -----	41 08 10.3	79 47 55.1
Farmington (Eau Clair post-office), 1 mile south of; crossroads; 25 feet northeast to telephone pole, 30 feet northwest to guide post "Eau Clair—Washington—Parker 7 miles," -----	41 07 23.0	79 48 07.2
Telephone pole in centre of triangle at forks of road to north and northeast, guide board "N. Hope 4 miles—Eau Clair 3 miles," -----	41 06 26.5	79 47 14.1
Shira post-office (Annsville), crossroads at; 12 feet west to centre of bridge, 12 feet east to centre of bridge, 40 feet northwest to com- pany store, 30 feet southeast to locust tree and guideboard "Parker 7 miles—Hilliards 2.5 miles—Eau Clair 4.5 miles—N. Hope 2.5 miles," -----	41 04 56.8	79 47 51.5
Parsonville, 0.8 mile north of; T road east; 40 feet west to large oak tree, 15 feet east to centre of triangle, 40 feet southeast to tele- phone pole, -----	41 04 23.0	79 48 08.3
North Washington, 1 mile north of; crossroads; 10 feet east to two- plank bridge, 40 feet southwest to three-pronged maple, -----	41 03 34.5	79 48 30.0
North Washington (N. Hope post-office), crossroads at; 30 feet northwest to southeast corner of brick house, 40 feet northeast to southeast corner of store, -----	41 02 52.5	79 48 49.1
North Washington, 1 mile (about) southeast of; crossroads; 300 feet west of Emery schoolhouse; 20 feet southwest to guidepost "Bruin 6 miles—Butler road 1 mile—Fairview 5 miles—N. Hope 1 mile—," 70 feet northwest to telephone pole, -----	41 02 28.8	79 47 58.9
North Washington, 2 miles southeast of; large chestnut tree on south edge of east and west road at four-corners, -----	41 02 05.0	79 47 03.6
Ray Run schoolhouse, 0.33 miles north of; crossroads, 40 feet west to centre of bridge, 30 feet southwest to S. R. McRockens mail box, Fairview, 0.8 mile southwest of; T road west; 12 feet east to Walnut tree, 35 feet southwest to corner of fence and guide board "Fair- view 0.8 mile—Washington 4.5 miles," fence painted "U. S. 1354," --	41 01 05.0	79 46 24.5
	41 00 37.4	79 45 33.9

Magnetic Declination of west border of quadrangle is 4° 19' west.

Geographic positions along highways.

Cyrus post-office, 1.25 miles southeast of, large tree in triangle at forks of old roads near old house place, about 0.5 mile west of Allegheny River, -----	41 14 09.9	79 47 26.1
St. George station, centre of P. R. R. main track at crossing, 1,200 feet north of milepost 30, -----	41 14 57.1	79 47 31.8

OIL CITY QUADRANGLE.

Geographic positions along highways.

Stations.	Latitude.	Longitude.
	° ' "	° ' "
Pittsville, 150 feet north of hotel; public T road east; 30 feet north-east to telephone pole painted "G. S. 1312," 30 feet west to north-west corner of shop, -----	41 15 23.3	79 44 26.7
Pittsville, in northeast corner of front yard of Bishop's hotel, 60 feet southwest of T road east; iron post stamped "Prim. Trav. Sta. No. 4-1908-PENNSYLVANIA," -----	41 15 22.7	79 44 26.8
Pittsville, 1.4 miles east of; T road west; centre of north and south road at, 10 feet west to centre of triangle, 25 feet southwest to sign "Freedom 1 mile-Salina 7 miles-Dotters Station 3 miles," -----	41 15 19.9	79 42 59.3
Three-corners, second class T road north, 75 feet east of small bridge over stream, -----	41 15 22.2	79 42 09.0
Beels triangulation station, 2 miles west of, crossroads, 15 feet south to sign "Emlenton 7 miles," 19 feet north to water trough, -----	41 15 22.8	79 41 09.4
Beels triangulation station, 1.25 miles west of, T road east, 5 feet west to centre of north and south road, 30 feet north to telephone pole painted "G. S. 1447," 20 feet north to sign "Edenburg 7 miles," -----	41 15 13.6	79 40 08.9
Beels triangulation station, 0.5 mile west of, crossroads at school-house, centre of triangle at, -----	41 15 13.9	79 39 13.5
Beels triangulation station, about 3 miles north of Salem, in Salem Township, on a bare knob with timber on north side. On an east and west line fence, which is also the county line between Clarion and Venango counties; stone post 36 by 8 by 8 inches set 30 inches in ground, in centre of top of which is cemented a bronze tablet stamped "U. S. G. S.-PENNSYLVANIA," -----	41 15 14.00	79 38 47.07
Rockland post-office, 0.5 mile south of; crossroads, 20 feet southwest to sign "St. George 3 miles," 30 feet north to telephone pole, -----	41 16 18.8	79 44 57.2
Rockland post-office, crossroads at; 25 feet southwest to telephone pole and sign "Nickleville 6 miles-Scrubgrass 6 miles," 30 feet northwest to telephone pole and sign "Franklin 12 miles-Emlenton 9 miles," -----	41 16 39.2	79 44 56.8
Reno, 1.8 miles northeast of, three-corners, at bend of main road to west, second class road to east, 40 feet south to stream crossing, 50 feet east to willow, -----	41 25 51.7	79 44 40.7
Reno, 2.25 miles northeast of, three-corners T road west, centre of triangle at; 30 feet south to oak and sign "Twomile Run road 1.5 miles-Reno 2 miles-Dempseytown 7 miles," -----	41 26 31.3	79 44 44.9
Oil City, 2 miles northwest of; forks of road southwest and south-east, centre of triangle at; 35 feet southwest to oak tree and sign "Oil City 2 miles-Reno 3.5 miles," -----	41 27 27.8	79 44 16.4
Rynd Farm, 2 miles west of, crossroads; 35 feet northwest to front yard fence, 25 feet northeast to sign "Oil City 3 miles-Cherrytree 4 miles-Franklin 8 miles-Rynd Farm 2 miles," -----	41 28 29.8	79 44 06.0
White Church, 600 feet northwest of, T road southwest; 15 feet south to sign "Franklin road 1 mile," -----	41 29 24.9	79 44 40.5

TOWNVILLE QUADRANGLE.

Geographic positions along highways.

Dempseytown, 2 miles southeast of, in southeast corner 30 feet south of intersection of Franklin-Titusville road with the Oil City-Dempseytown road, about 6 miles northwest of Oil City; iron post stamped "Prim. Trav. Sta. No. 61-1908-PENNSYLVANIA," -----	41 30 08.9	79 45 06.4
Dempseytown, 2 miles southeast of, intersection of Franklin-Titusville road with the Oil City-Dempseytown road; 30 feet south to Prim. Trav. Station No. 6," -----	41 30 09.2	79 45 06.4
Dempseytown, 1.5 miles southeast of, T road north; centre of small bridge at, -----	41 30 24.1	79 45 31.1
Dempseytown, crossroads at store; 50 feet northwest to corner of store, 30 feet east to sign "Franklin 9 miles-Titusville 10 miles-Twomile Run 2 miles-Sunville 4 miles," -----	41 30 41.5	79 46 48.3
Dempseytown, 1.0 mile west of, four-corners; 110 feet northwest to oak, 12 feet southwest to corner of fence, 80 feet southeast to sign "Franklin road 1 mile," -----	41 30 39.7	79 47 58.4
Dempseytown, 2.0 miles west of, guidepost in angle of forks, sign reads "Sunville road 0.5 mile," -----	41 30 20.8	79 49 20.5
Cooperstown, in north corner of yard to hotel in the southwest corner of intersection of Main and Mill street, 22 feet west of center of Main street, and 25 feet south of intersection of streets; iron post stamped "Prim. Trav. Sta. No. 7-1908-PENNSYLVANIA," -----	41 30 04.8	79 52 26.1
Cooperstown, 0.8 mile west of, T road south, centre of triangle at, 35 feet west to sign "Hannaville 6 miles-Cochrantown 10 miles," -----	41 30 06.9	79 53 10.6

TOWNVILLE QUADRANGLE—Continued.

Stations.	Latitude.	Longitude.
Schoolhouse, 150 feet northeast of, T road northeast, centre of triangle at, 15 feet west to two mail boxes, 30 feet south to sign "Deckard 3 miles—Cooperstown 3 miles,"	41 30 14.0	79 55 19.0
Four-corners at top of small hill, crossroads, stone in centre of intersection of; 60 feet southeast to oak, 15 feet northeast to sign "Cochrannton 6 miles—Cooperstown 4 miles—Deckard 2 miles—Hannanville 1.5 miles,"	41 30 05.8	79 57 01.4
Schoolhouse, 1,500 feet east of, T road south, north edge of east and west road at; 20 feet northwest to chestnut tree, 15 feet south to centre of triangle,	41 30 00.9	79 58 22.9
Cochrannton, about 4.0 miles southeast of, on east edge of Franklin-Meadville turnpike, 20 feet south of junction with road leading east to Cooperstown, near line between Crawford-Venango County Line; iron post stamped "Prim Trav. Sta. No. 8—PENNSYLVANIA—1908,"	41 30 03.6	79 59 35.4
Cochrannton, about 4.0 miles southeast of; junction of Franklin-Meadville turnpike with road east to Cooperstown on or near county line,	41 30 03.8	79 59 35.4

MERCER QUADRANGLE.

Geographic positions along highways near north border of quadrangle.

Mercer Station, 300 feet east of; centre of street crossing Pennsylvania Railroad,	41 13 33.1	80 13 32.8
Crossing of Bessemer and Pennsylvania railroads, centre of Pennsylvania track between Bessemer double tracks,	41 13 54.1	80 12 31.3
Turners Station, 50 feet west of; road crossing,	41 14 28.3	80 11 12.8
Turners Station, 1 mile east of; centre of triangle at T road west,	41 14 39.6	80 10 20.2
Turners Station, 2 miles east of; crossroads, 30 feet to guidepost "Pardoe 2 miles—Millbrook 5 miles,"	41 14 31.5	80 09 02.0
Barnes crossroads, 35 feet southeast to guide board "Sandy Lake 8 miles—Grove City 7 miles,"	41 14 54.0	80 07 29.5
Hazzard Schoolhouse, at southwest corner of, at T road north, 4 miles east of Turners Station, 400 feet to T road south; iron post stamped "Prim. Trav. Sta. No. 1 PENNSYLVANIA 1908,"	41 14 55.6	80 06 26.4
Hazzard Schoolhouse, at T road north; centre of triangle,	41 14 55.3	80 06 25.4
Hazzard Schoolhouse, 1.2 miles east of, centre of T road north, 10 feet north to centre of triangle, 25 feet northeast to guide board "Bradley Road 1 mile,"	41 14 56.1	80 05 04.5
Millbrook, 0.8 miles west of, four-corners; 40 feet northwest to guide board "Millbrook 0.8 mile—Mercer 10.25 miles—Sandy Lake 8 miles—Grove City 7 miles,"	41 14 56.5	80 04 29.8
Millbrook, centre of iron bridge over Wolf Creek at,	41 14 57.4	80 03 42.0
Millbrook, 0.8 mile east of, crossroads; 35 feet northeast to guidepost "Henderson 3.8 miles—Harris 7 miles—Wesley 6 miles—Millbrook 0.8 miles,"	41 14 58.2	80 02 43.4

Magnetic Declination of north border of quadrangle is 3° 16' west.

Geographic positions along highways near east border of quadrangle.

Crossing of Mercer-Venango County Line at fence row 1,600 feet east of T road south,	41 13 54.0	80 00 00.7
Bridge over stream, 400 feet east of, north edge of east and west road at T road north, 20 feet southeast to centre of triangle, 15 feet north to wire fence,	41 13 11.1	80 00 13.5
Crossroads; 30 feet southeast to corner rail fence, 20 feet northeast to corner rail and wire fence,	41 11 49.3	80 00 13.6
Crossroads, 15 feet south to small bridge, 25 feet southeast to signboard "Kohlmyers Hardware Grove City 4.8 miles," 20 feet northwest to peach tree,	41 11 17.0	80 00 18.6
Crossroads; 35 feet northwest to two mail boxes; 20 feet east to gate, Harrisville, 1.5 miles north of, centre of Pittsburg pike at T road west; 20 feet west to centre of small bridge, 40 feet southwest to guide board "Hendersonville Road 0.5 mile,"	41 10 37.2	80 00 24.1
Harrisville, intersection of the Pittsburg-Franklin and Mercer-Roseburn pikes at Central House; 45 feet southwest to front door of store, 45 feet northwest to southeast corner of Central House,	41 09 14.0	80 00 15.6
	41 08 12.3	80 00 34.2

MERCER QUADRANGLE—Continued.

Stations.	Latitude.	Longitude.
	" " "	" " "
Harrisville High School Grounds, in the northeast corner of, 25 feet northeast to school building and 420 feet west of the Pittsburg pike; iron post stamped "Prim. Trav. Sta. No. 11 PENNSYLVANIA 1908,"	41 08 08.4	80 00 33.3
Forestville post-office, 4-corners at blacksmith shop, 40 feet northeast to corner of shop, 30 feet southeast to guide post "Harrisville 2 miles—Butler 13 miles—Courtneys Mills 3.5 miles—Murrens 7 miles,"	41 06 21.6	80 00 21.9
Center of pike at Mercer-Slippery Rock township line crossing at T road east to barn at end of Madadan road,	41 05 50.6	80 00 16.3
Forestville, 1 mile south of, centre of triangle at roads to southeast and southwest; 35 feet southeast to centre of bridge, 60 feet south to guide board "Harrisville 3 miles," 40 feet north to centre of bridge,	41 05 37.9	80 00 09.5
East edge of pike at T road east; 25 feet south to corner plank fence and guide board "New Hope 2 miles—Harrisville 4 miles—Keister 2 miles,"	41 05 03.4	80 00 04.2
Keister, 1 mile north of, crossroads; 35 feet northeast to double elm and guide board "Slippery Rock 3 miles—Branchton 1 mile—Keister 1 mile—Harrisville 6 miles," 30 feet southwest to corner rail fence,	41 04 28.2	80 00 08.3
Stonehouse, crossing of Mercer-Butler pike and Pittsburg pike at; 40 feet southeast to J. J. Gills mailbox, 60 feet southwest to large stone on west side of pike,	41 00 40.8	80 00 08.7

Magnetic Declination of east border of quadrangle is 4° 19' west.

PENNSYLVANIA—MARYLAND.

EMMITSBURG AND HAGERSTOWN QUADRANGLES.

FREDERICK AND WASHINGTON COUNTIES, MD.
FRANKLIN COUNTY, PA.

The following geographic positions on U. S. standard datum were determined by Geo. T. Hawkins from primary traverse run in 1909.

The line starts from Quirauk triangulation station and follows highways westward, southward, eastward and northward near borders of quadrangle. Another line was run through the centre of the quadrangle from south to north and a tie was also obtained by a line run from southeast corner of quadrangle to a point near Hansonville, located by primary traverse in 1907.

HAGERSTOWN QUADRANGLE.

(Pennsylvania Portion.)

Geographic positions along highways in northern part of quadrangle.

Stations.	Latitude.	Longitude.
	" " "	" " "
Greenerton (a station on W-M Ry.), 0.25 mile south of, road west at three corners,	39 43 50.2	77 40 01.3
Trolley line crossing 1½ miles west of Greenerton,	39 43 51.3	77 41 31.4
Good road to north, three corners, 450 feet east of house,	39 43 38.6	77 42 43.9
State line, four corners at,	39 43 20.4	77 43 28.8

Magnetic Declination of north edge of quadrangle 5° 06' west.

PENNSYLVANIA—MARYLAND.

HAGERSTOWN QUADRANGLE.

WASHINGTON AND FREDERICK COUNTIES.

Geographic positions along highways in northern part of quadrangle.

Stations.	Latitude.	Longitude.
	" " "	" " "
Quirauk triangulation station, on line between Frederick and Washington counties, about 2 miles south of Pen Mar, Pa., and about 2 miles southeast of Blue Mountain, Md. On highest point of mountain locally known by same name. Station mark: A bronze tablet marked "U. S. Geol. Survey—Penna.," countersunk in a dressed stone 4 feet long and 10 inches square, set flush with top of ground under centre of tower, which is made of iron and 84 feet high, -----	39 41 47.92	77 30 45.72
Ringold, 0.8 mile east of; T road west, -----	39 41 49.2	77 33 05.6
Ringold, crossroads at, -----	39 42 34.6	77 34 01.9
T road south near row of large willows, -----	39 42 28.1	77 34 46.6
Second class road north, -----	39 42 05.9	77 36 18.7
Centre of crossroads Leitersburg, -----	39 41 33.5	77 37 22.6
Turn northwest.		
Leitersburg, Md., 850 feet north of crossroads at, in solid limestone ledge on east side of road leading north from and 30 feet from front door of Mr. Myers; aluminum tablet, -----	39 41 40.1	77 37 29.4
Cross pikes 1 mile north and 1 mile west of Leitersburg, -----	39 42 39.2	77 38 37.2
Stone 12 inches square marked "M" on south and "P" on north (State Line), -----	39 43 14.2	77 39 14.1
State line, on west side of pike, 15 feet from middle of pike, 60 feet northwest of pike and state line road leading to railway stations, set in solid rock on state line; aluminum tablet, no marks, -----	39 43 17.1	77 43 28.6
State Line, 1 mile south of, fork to northeast, north and south, --	39 42 18.4	77 43 23.0
Concrete post on state line, marked "MD." on south and "P" on north in south part of state line, -----	39 43 15.5	77 43 28.0
Toll gate 3 miles south of state line, -----	39 40 13.8	77 43 11.4
Hagerstown, about 1.5 miles north of, on County Farm, set in driveway from pike to main building; south stone, marble 8 by 8 by 42 inches set 38 inches in ground; stamped "Prim. Trav. Sta. No. MD.," -----	39 39 50.0	77 43 07.0
Hagerstown, corner of W. North street and Jonathan street, -----	39 38 53.2	77 43 08.6
Hagerstown, corner N. Locust and E. Franklin streets; 1 block north and 1 block east of square, -----	39 38 31.2	77 43 02.3
Hagerstown, crossing Sharpsburg pike and Baltimore and Ohio Railway, south part of, -----	39 37 40.3	77 43 35.9

Magnetic Declination of north edge of sheet 5° 06' west.

Geographic positions along highways in west border of quadrangle.

Toll gate on Sharpsburg pike at road west, -----	39 37 23.3	77 43 43.3
Crossroads, log house in southeast corner, -----	39 36 43.8	77 43 52.8
T west gate on east side road, -----	39 35 48.0	77 43 50.9
Three corners near schoolhouse, -----	39 35 16.0	77 43 55.7
Toll gate and T road east, -----	39 33 55.7	77 43 52.8
Crossing Sharpsburg and Hagerstown pike with Williamsport and Boonsboro pike, -----	39 33 13.3	77 44 16.8
Tilghman, about 0.25 mile north of, on east side of pike, 720 feet towards Hagerstown pike crossroad, in north edge of, 15 feet to telephone pole on east side of road, on top of little hill, in solid rock; aluminum tablet, no marks, -----	39 32 23.9	77 44 22.2
Bitner station, 300 feet south of, crossing B. & O. Ry., -----	39 31 26.8	77 43 14.6
East end of iron bridge over Antietam Cr., -----	39 31 02.2	77 42 07.0
Monroe Church, 200 yards northeast of, first three corners from church, -----	39 31 01.2	77 41 25.2
Hotel Boonsboro, four corners at, -----	39 30 22.1	77 39 09.4

Geographic positions along highways in southern border of quadrangle.

Three corners 200 feet east of two mail boxes, -----	39 30 57.9	77 37 54.0
Narrow summit where road crosses divide old fields north and south of road, -----	39 31 39.1	77 36 47.6
Centre of triangle at three corners on north of Cr. House, 600 feet southwest, on west side of road, -----	39 31 42.8	77 35 33.9
Crossing electric railway just west of three corners, -----	39 31 06.2	77 34 47.3

HAGERSTOWN QUADRANGLE. PENNSYLVANIA-MARYLAND—Continued.

Stations.	Latitude.	Longitude.
	° ' "	° ' "
Meyersville, in north part of, three corners at Mt. Zion Church, ----	39 30 43.1	77 34 10.5
Churchhill, 600 feet southeast of St. John Lutheran Church, three		
corners at small bridge, ----	39 31 28.5	77 33 09.2
Ellerton, south end of iron bridge at, ----	39 31 36.7	77 32 37.2
Three corners on top of hill, ----	39 31 05.9	77 31 30.4
Highland Church, 500 feet north of, T road east, ----	39 31 24.7	77 31 07.8
Second class fork north, ----	39 32 01.3	77 30 37.1

Geographic positions along line through centre of quadrangle, North and South.

Iron bridge, ----	39 40 57.0	77 37 45.0
T road to southwest, 400 feet northwest of big stone house, ----	39 39 32.7	77 37 48.7
Chewsville, forks south from pike in, at post-office, ----	39 38 34.2	77 38 07.8
Chewsville, 0.5 mile south of; three corners, ----	39 38 05.2	77 37 52.4
Crossroads near Beaver Creek, 30 feet southeast to Barnhart's mail		
box, ----	39 37 21.2	77 36 32.9
Mt. Etna, crossroads at schoolhouse, ----	39 36 08.0	77 37 28.1
Three corners north end of Beaver Creek, ----	39 34 59.4	77 38 35.3
Four corners at Lt. Ry. junction at Crossroads post-office, ----	39 34 25.9	77 38 48.8
Forks to southeast at trolley station, ----	39 33 08.0	77 38 48.2
Mapleville, T road west at Brown Church, ----	39 32 29.3	77 38 51.1
Second class T road east between house and barn, ----	39 31 37.9	77 38 50.8
Boonsboro, north part of, junction of Smithburg road and Hagers-		
town pike, ----	39 30 44.5	77 39 22.2

Geographic positions along highways in east border of quadrangle.

Big Spring, 200 feet north of the five forks at, on east side of north		
and south lane, 50 feet northwest of Mrs. Jackson's house and 20		
feet east of large cherry tree, set in large rock in place 4 by 6 feet;		
aluminum tablet, no marks, ----	39 32 57.7	77 30 04.9
Five forks at Big Springs, ----	39 32 55.7	77 30 05.4
Forks of road to east 70 feet north to mail box Nos. 47 and 48, ----	39 35 29.6	77 30 00.2
Forks of roads northwest and northeast, ----	39 36 01.4	77 30 16.3
Well traveled road to southeast at mail box, G. B. Green, ----	39 36 30.6	77 30 04.0
Forks of roads on top of hill, ----	39 39 45.4	77 30 17.9
Forks of roads about 200 feet southeast of two-story brown house, -	39 39 48.9	77 31 51.4
Edgemont, 0.5 mile southwest of, road under trestle of W-M, ----	39 39 57.9	77 33 01.2
Three corners at Lutheran Church and Ry. schoolhouse, ----	39 40 28.2	77 33 12.7
T road at brick schoolhouse, ----	39 41 25.5	77 33 23.0

PENNSYLVANIA-MARYLAND.

EMMITSBURG QUADRANGLE.

ADAMS AND FRANKLIN COUNTIES, PENNSYLVANIA, CARROLL FRED-
ERICK AND WASHINGTON COUNTIES, MARYLAND.

Geographic positions along highways in western edge of quadrangle.

Stations.	Latitude.	Longitude.
	° ' "	° ' "
Road to west down hill 1.5 miles north of Big Spring, ----	39 34 10.0	77 29 58.4
Well traveled forks at sharp bend to west—other road goes to north-		
east, ----	39 34 46.0	77 29 54.7
Crossroads, lanes east and north, roads south and west, ----	39 37 17.3	77 29 29.9
Foxes' store, 1,070 feet north to, crossroads at Foxville, Pike east		
and west, 60 feet north and east to small store, ----	39 38 10.2	77 29 50.0
T road east, south of Lutheran Church, ----	39 38 50.0	77 29 45.6

EMMITSBURG QUADRANGLE. PENNSYLVANIA-MARYLAND—Continued.

Geographic positions along highways in south edge of quadrangle.

Stations.	Latitude.	Longitude.
	° ' "	° ' "
Second class road north, -----	39 32 04.8	77 28 25.6
Second class road to south, 500 feet to sawmill, -----	39 31 38.7	77 28 11.1
Three corners north of creek near old sawmill site, -----	39 31 11.3	77 27 05.4
Crossroads at concrete church, Mountindale, -----	39 31 12.3	77 26 13.7
Railway crossing at flag station on Thurmont and Frederick Ry., ---	39 31 05.3	77 25 32.5

APPENDIX C.

RESULTS OF SPIRIT LEVELING IN PENNSYLVANIA FOR THE YEAR 1908.

The readjustment in 1903 of the precise-level net in the eastern portion of the United States by the Coast Survey necessitated a corresponding readjustment of all spirit-level heights of the United States Geological Survey dependent thereon.

All results of leveling in Pennsylvania published prior to that time, as well as levels not previously published were then readjusted, rearranged by quadrangles and published in Bulletin 288 of the United States Geological Survey, and also published in the report of this Commission for 1899-1906.

The elevations are arranged according to the degree of accuracy of their determination, precise and primary. The former are determined by lines of levels run either in both forward and backward directions or by simultaneous double-rodged lines, a high-grade instrument being used and special precautions being taken in observations and reductions to correct errors and make the line continuously good throughout. The latter or primary levels are determined with the Y level, precautions being taken against only the principal errors and the levels being run mostly in circuits of single lines. The allowable limit of error observed on the precise work already done by the Geological Survey in this State is represented in feet by $0.03 \sqrt{D}$ and that for the primary work by $0.05 \sqrt{D}$, in which D is the length of circuit in miles.

The bench marks are of two general forms. First, a circular bronze or aluminum tablet $3\frac{1}{2}$ inches in diameter and one-fourth inch thick, appropriately lettered, having a three-inch stem cemented into a drill-hole, generally in the vertical walls of public buildings, bridges abutments, or other substantial masonry structures. The second form, employed where masonry or rock is not accessible, consists of a hollow wrought iron post 4 feet in length and $3\frac{1}{2}$ inches in outer diameter, split at the bottom and expanded to 12 inches so as to prevent both the easy subsidence of the post and its being maliciously pulled out of the ground. The iron is heavily coated with asphalt and over the top of the post is riveted a bronze tablet similar to that described above.

The numbers stamped upon the bench marks represent the elevations to the nearest foot above mean sea level, as determined by unadjusted levels in the field. They have been subjected to changes resulting from the adjustments necessary to close circuits and to those resulting from the reduction to mean sea level through readjustment of the precise level net of the United States. In some cases the finally accepted elevations as printed herein differ from those submitted as bench-mark numbers by 1 or 2 feet. This method of numbering bench marks has been adopted where many levelmen are working in the same area at the same time, as less liable to lead to confusion in identification of bench marks than any attempt at serial numbering, and because the bench mark number at the same time gives an approximate statement of the elevation. It is assumed that engineers and others finding these bench marks so stamped in the field will communicate with the Director of the United States Geological Survey in order to obtain the accepted elevation to hundredths or thousandths of a foot.

Any person finding bench marks mutilated or destroyed will confer a favor by notifying the Director, United States Geological Survey, Washington, D. C., or the office of the State Survey.

FRANKLIN, HILLIARDS, MERCER, AND STONEBORO QUADRANGLES.

MERCER AND VENANGO COUNTIES.

The elevations in the following list are based upon the 1907 adjustment of precise leveling. For additional elevations in the Franklin and Hilliards quadrangles refer to precise line—Erie to Pittsburg—in bulletin 288, U. S. Geological Survey.

The leveling was done in 1908 by H. W. Peabody and Wm. Oram.

The leveling was done in co-operation with the state and standard bench marks are stamped with the state name.

FRANKLIN QUADRANGLE.

SUGAR CREEK, NORTH ALONG HIGHWAYS, TO COOPERSTOWN;
THENCE EAST TO TWOMILE RUN; THENCE SOUTHWEST TO
FRANKLIN.

	Feet.
Sugar Creek, 1,200 feet southeast of, in northeast end of abutment of railroad bridge; bronze tablet stamped "1013 PITTSBURG 1899,"	1,013.628
Sugar Creek, 1.0 mile north of, at southeast corner of bridge at road forks; chisel mark,	1,043.99
Wyattville, driveway to house on east side of road at T road west; chisel mark on curb,	1,057.64
Cooperstown, 3.0 miles south of, in top of wing wall at southwest corner of iron bridge over Sugar Creek; aluminum tablet stamped "1084 1908,"	1,083.773
Cooperstown, 2.0 miles south of, in south root of 18-inch black oak at northwest corner of T road west; nail,	1,101.25
Cooperstown, 0.8 mile south of, on rock at northwest corner of road forks by schoolhouse; chisel mark,	1,121.04
Cooperstown, north end of town, in hotel yard at southwest corner of crossroads; iron post stamped "1146 1908,"	1,145.759
Cooperstown, on wing wall at northeast corner of bridge over Sugar Creek; chisel mark,	1,130.78
Cooperstown, 2.5 miles east of, on large rock at east side of road, 50 feet north of road to west; chisel mark,	1,486.37
Oakland schoolhouse, 2.0 miles south of Dempseytown, in north face of northwest corner of schoolhouse at southwest corner of crossroads; aluminum tablet stamped "1529 1908,"	1,528.773
Oakland schoolhouse, 1.0 mile east of, on rock at southwest corner of road forks; chisel mark,	1,397.32
Pritchard schoolhouse, 2.0 miles southeast of Dempseytown, in east face of southeast corner of schoolhouse; aluminum tablet stamped "1251 1908,"	1,250.968
Pritchard schoolhouse, 0.5 mile south of, on rock at centre of road forks; chisel mark,	1,329.96
Pritchard schoolhouse, 1.5 miles south of, on stone at west side of road forks; chisel mark,	1,240.01
Pritchard schoolhouse, 2.5 miles south of, on stone at southwest corner of bridge over west fork at road forks; chisel mark,	1,149.71
Eclipse station, 2.5 miles north of, in stone at northwest corner of bridge over Two Mile Run; aluminum tablet stamped "1100 1908,"	1,099.550
Eclipse, 0.5 mile east of, in bridge seat at southeast corner of Erie R. R. bridge over Two Mile Run; aluminum tablet stamped "981 1908,"	981.103
Franklin, in belt course of Erie Railroad station, northeast corner; aluminum tablet stamped "989 PITTSBURG 1899,"	989.349
Franklin, 40 feet south of Pennsylvania Railroad tracks, 70 feet west of station; iron post stamped "Prim. Trav. Sta. No. 5,"	984.737

FRANKLIN, WEST ALONG LAKE SHORE AND MICHIGAN SOUTHERN RAILROAD, TO COUNTY LINE.

	Feet.
Miles station, in top of concrete retaining wall at southwest corner of railway and road crossing and close to right-of-way; aluminum tablet stamped "1151 1908,"	1,151.476
Polk, in south face of southeast corner of Administration Building of State Institution for Feeble-Minded; aluminum tablet stamped "1116 1908,"	1,116.099
Polk, 1.0 mile west of, on wing wall at northeast corner of road bridge over Big Sandy Creek, 300 feet north of railroad; chisel mark,	1,069.83
Raymilton, in top of northwest corner of concrete culvert about 100 feet east of undergrade road crossing; aluminum tablet stamped "1123 1908,"	1,123.385

RAYMILTON, SOUTH TO NEAR WESLEY.

Raymilton, 0.8 mile south of, on large rock at southwest corner of crossroads; chisel mark,	1,310.02
Raymilton, 2.5 miles south of, 0.5 mile north of South Sandy Creek, on rock at northwest corner of bend to west,	1,400.67
Raymilton, 3.0 miles south of, in bridge seat at northwest corner of small wooden bridge over South Sandy Creek 100 feet south of T road west; aluminum tablet stamped "1196 1908,"	1,195.772

KENNERDELL STATION SOUTHWEST TWO MILES.

Kennerdell, 1.5 miles south of, 300 feet west of milepost 106, 10 feet north of centre of track, 2.4 feet above rail, in large boulder; bronze tablet stamped "941 PITTSBURG 1899," (nothing left on this tablet but the shank),	942.373
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UTICA NORTHWEST TO RAILROAD BRIDGE.

Utica, 300 feet south of station, in east abutment, north side of highway bridge; bronze tablet stamped "1038 PITTSBURG 1899,"	1,038.328
Utica, 2.25 miles north of, on stone at southwest corner of railroad bridge; chisel mark,	1,041.79

STONEBORO QUADRANGLE.

FROM NEAR UTICA, NORTHWEST TO CARLTON; THENCE WEST ALONG HIGHWAY TO SUNOL; THENCE SOUTHWEST TO HADLEY.

Carlton, in top stone at northeast corner of road bridge over French Creek; aluminum tablet stamped "1052 1908,"	1,052.034
Milledgeville, in south face of southwest corner of Presbyterian Church, 500 feet east of crossroads; aluminum tablet stamped "1280 1908,"	1,279.937
Milledgeville, 1.0 mile west of, on rock at northwest corner of crossroads; chisel mark,	1,423.13
Milledgeville, 1.8 miles west of, at southeast corner of road to south; chisel mark,	1,325.79
Sunol, 1.0 mile east of, at southwest corner of crossroads; chisel mark,	1,380.15
Sunol, 4.0 miles northeast of Sheakleyville, in west face of southwest corner of J. F. Turner's dwelling at road forks by store; aluminum tablet stamped "1408 1908,"	1,407.808
Chisel mark on rock at southwest corner of small iron bridge over Sandy Creek,	1,194.69
Sheakleyville, in south face of southeast corner of U. P. Church at south edge of village; aluminum tablet stamped "1282 1908," ...	1,282.351

FROM COUNTY LINE NEAR RAYMILTON, WEST ALONG LAKE SHORE AND MICHIGAN SOUTHERN RAILROAD, TO HADLEY.

Raymilton, 2.0 miles west of, on top of parapet wall at northeast corner of railroad bridge No. 227 over road (road 1136 feet); chisel mark,	1,153.90
Sandy Lake, 2.0 miles east of, on large boulder at northwest corner of road crossing; chisel mark,	1,157.97
Blairs crossing, 1.0 mile east of Sandy Lake, in bridge seat at southeast corner of iron bridge over Big Sandy Creek about 30 feet north of railroad; aluminum tablet stamped "1153 1908,"	1,153.128

	Feet.
Stoneboro, in foundation stone 1.7 feet above step at left side of entrance to First National Bank at northeast corner of Lake and Walnut streets; aluminum tablet stamped "1184 1908,"	1,184.519
Clarks Mills station, in next to top stone in back wall at northwest corner of railroad bridge over Little Shenango River, 500 feet east of station; aluminum tablet stamped "1160 1908,"	1,160.122
Hadley, in bridge seat at northwest corner of iron bridge over Little Shenango River; aluminum tablet stamped "1049 1908,"	1,048.072
Kashner, 3.0 miles north of, in northwest wing wall of iron bridge spanning Otter Creek; aluminum tablet stamped "1005,"	1,005.329

STONEBORO SOUTHWEST ALONG PENNSYLVANIA RAILROAD, TO TURNER STATION.

Lyon, 0.5 mile north of, 200 feet east of railroad, in north face of northwest corner of Centre schoolhouse; aluminum tablet stamped "1385 1908,"	1,384.870
Jackson Center station, 1.0 mile north of, about 500 feet north of crossing, on northwest corner of concrete bridge,	1,266.71
Jackson Center station, 0.4 mile north of, on rock at northeast corner of crossing; chisel mark,	1,263.03
Turners station, 0.5 mile north of, in wing wall at southeast corner of small iron bridge of Pennsylvania Railroad; aluminum tablet stamped "1133 1908,"	1,132.597

MILLBROOK, NORTHWEST ALONG HIGHWAY, TO JACKSON CENTER.

Bowie schoolhouse, at southwest corner of, at northwest corner of road to north; iron post stamped "Prim. Trav. Sta. No. 1,"	1,378.415
Jackson Center, 0.8 mile east of, on bridge seat at southeast corner of iron bridge at crossroads by railroad; chisel mark,	1,275.55
Jackson Center, in south face of water table at southeast corner of C. P. Church at east end of village; aluminum tablet stamped "1318 1908,"	1,317.633

HILLIARDS QUADRANGLE.

QUEEN JUNCTION, NORTH ALONG ROAD, TO BRANCHTON; THENCE EASTERLY VIA ANNANDALE AND NORTH HOPE, TO BRUIN.

Queen Junction, at junction of Bessemer and Western Allegheny Railroad, in concrete bridge abutment; aluminum tablet stamped "1226 ADJ 1903,"	1,225.945
Queen Junction, 0.7 mile north of, east of north bound track, base of switch signal, letter "s" in word works; painted "1249,"	1,248.77
Sherwin, 0.2 mile south of, 100 feet south of abandoned coal mine west of south bound track, emergency rail track, most southerly of three posts; piece of iron in post; painted "1274,"	1,274.18
Sherwin, 250 feet along highway west of railroad, 20 feet west of house of Peter Sherwin, in boulder at side of road; aluminum tablet stamped "1286 ADJ 1903,"	1,285.737
Claytonia, in front of station; top of rail,	1,236.2
Halston, 0.5 mile north of, 50 feet east of railroad along highway, in boulder at road side; aluminum tablet stamped "1196 ADJ 1903,"	1,196.103
Keister, in front of station; top of rail,	1,183.5
Branchton, in front of station; top of rail,	1,196.2
Branchton, 100 feet back of station, in concrete foundation under porch to house of Ames Hall; aluminum tablet stamped "1190 ADJ 1903,"	1,189.863
Bovard, in front of station; top of rail,	1,190.9
Bovard, 2.4 miles east of, 200 feet south of track, in field of James M. Hogg, in boulder; aluminum tablet stamped "1193 ADJ 1903,"	1,192.720
Annandale, at station, grade crossing; top of rail; painted "1202,"	1,202.4
Annandale, 300 feet south of railroad, along highways, at residence of Reuben Byers, in retaining wall in front of house; aluminum tablet stamped "1214 ADJ 1903,"	1,214.084
Hilliard, 0.1 mile north of station, at grade crossing, 100 feet north of track, at rear of M. E. Church, in foundation stone; aluminum tablet stamped "1264 ADJ 1903,"	1,263.721
Hilliard, 0.9 mile south of, midway to summit, in boulder; chisel mark; painted "1420,"	1,420.29

	Feet.
North Hope, 1.2 miles north of, at intersection of roads, at fence, on rock; chisel mark; painted "1457,"	1,457.56
North Hope, 0.8 mile north of, at intersection of roads, 200 feet east of church, in root of tree; tacks; painted "1488,"	1,488.26
North Hope, at crossroads, in foundation stone on west side of store, building owned by Julia Henden; aluminum tablet stamped "1503 ADJ 1903,"	1,503.094
North Hope, 0.7 mile east of, southeast corner of bridge in hollow on stone abutment; chisel mark; painted "1365,"	1,365.68
Bruin, 3.4 miles west of, at intersection of Bruin, Glenora and North Hope roads, in boulder at vertex of "Y"; aluminum tablet stamped "1278 ADJ 1903,"	1,277.824
Bruin, in southeast wing wall of iron bridge over Little Bear Creek; aluminum tablet stamped "1092,"	1,091.846

ANNANDALE, NORTH ALONG ROAD, TO BULLION.

Murrinsville, 300 feet west of crossroads, north side of road, in stone steps at front of residence of James C. Murrin; aluminum tablet stamped "1441 ADJ 1903,"	1,441.088
Murrinsville, 2 miles north of, in hollow, 5 feet south of bridge, on stone at side of road; chisel mark; painted "1414,"	1,413.88
Clintonville 1.5 miles south of 130 feet south of intersection on east side of road in stone steps west of house of W. C. Hovis; aluminum tablet stamped "1467 ADJ 1903"	1,466.989
Clintonville, 0.9 mile south of, 100 feet south of T road going west, on west end of stone culvert; chisel mark; painted "1467,"	1,467.05
Clintonville, at crossroads, at southeast corner, on flagstone crossing; chisel mark; painted "1435," (disturbed August 7, 1909), ...	1,437.88
Clintonville, 2 miles north of, on summit, east side of road, in foundation stone on south side of residence of I. J. Clay; aluminum tablet stamped "1442 ADJ 1903,"	1,442.090
Bullion, 1.5 miles south of, at brow of hill, on stone at side of road; chisel mark; painted "1383,"	1,383.45
Bullion, in foundation (1 foot above ground) in centre of north side of J. A. Dewoodey's store building, 50 feet south of road forks; aluminum tablet stamped "1466 1908,"	1,465.725

HILLIARDS QUADRANGLE.

KENNERDELL, WEST ALONG HIGHWAY, TO COUNTY LINE.

Kennerdell, 2.5 miles southwest of station, in top of wing wall at northeast corner of iron highway bridge over Scrubgrass Creek at Pump station; aluminum tablet stamped "Prim. Trav. Sta. No. 3 1029,"	1,029.360
Kennerdell, 3.5 miles west of, on rock at southwest corner of private road to left; chisel mark,	1,308.28
Bullion post-office, in foundation 1 foot above ground, in centre of north side of J. A. Dewoodey store building, 50 feet south of road forks; aluminum tablet stamped "1466 1908,"	1,465.725
Pike schoolhouse, 0.5 mile east of, 1.8 miles west of Bullion, 600 feet west of culvert, on fence corner stone; chisel mark, ...	1,411.900
Wesley, 1.0 mile north of, on Pittsburg and Franklin road, in east face of southeast corner foundation of J. C. Allen's house at southwest corner of crossroads; aluminum tablet stamped "1443 1908,"	1,443.594
Millbrook, 3.5 miles east of, on south side of road at T road north; iron post stamped "Prim. Trav. Sta. No. 2 1473,"	1,472.755

MERCER QUADRANGLE.

COUNTY LINE, WEST ALONG HIGHWAY, TO MILLBROOK.

Millbrook, 2.0 miles east of, on culvert stone at northeast corner of crossroads by schoolhouse; chisel mark,	1,406.34
Millbrook, 1.5 miles east of, on top stone at northwest corner of small iron bridge; chisel mark,	1,336.70
Millbrook, in bridge seat at southwest corner of iron bridge between road forks at west edge of town; aluminum tablet stamped "1306 1908,"	1,306.560

TURNER STATION, SOUTHWEST ALONG PENNSYLVANIA RAILROAD,
TO MERCER.

Mercer, in bridge seat at southwest corner of Pennsylvania Railroad bridge over Otter Creek, about 1,000 feet north of Penn. R. R. station; aluminum tablet stamped "1097 1908,"	1,097.391
Mecer, northeast corner of courthouse steps; aluminum tablet stamped "1277 ADJ 1903." (This elevation was taken on the same stone but about 6 inches from where the tablet was set, it having been set in a piece of stone that was broken off in clearing up the debris after the courthouse was burned),	1,276.839

JOHNSTOWN, MEYERSDALE, SOMERSET AND WINDBER
QUADRANGLES.

SOMERSET COUNTY.

Elevations based upon the 1903 adjustment.

Leveling in 1908 by T. A. Green.

MEYERSDALE QUADRANGLE.

ROCKWOOD NORTHEAST ALONG BALTIMORE AND OHIO RAILROAD
TO SOMERSET.

	Feet.
Rockwood, south end, mud wall, east abutment of bridge No. 34; copper bolt; (B. & O. Precise Levels),	1,810.512
Rockwood, in front of station; top of rail,	1,811.7
Rockwood, 0.9 mile northeast of, at signal house No. RX, 30 feet east of tracks, on sandstone rock, cross; marked "1823,"	1,822.70
Rockwood, 1.7 miles northeast of, south of tracks, on large boulder, point; marked "1853,"	1,852.96
Shamrock, 0.4 mile northeast of station, 72 feet east of railroad, 60 feet south of stream running west, in limestone rock; aluminum tablet stamped "1881-1908,"	1,881.244
Shamrock, 1.5 miles northeast of, 30 feet north of road crossing, west of railroad, on sandstone rock, point, marked "1913,"	1,913.18
Milford, 0.9 mile northeast of, 80 feet east of railroad, 250 feet south of house occupied by Samuel Walters, in sandstone boulder; aluminum tablet stamped "2013-1908,"	2,013.369
Milford, 2.1 miles northeast of, east of tracks at south end of fill, on oblong sandstone boulder, point; marked "2058,"	2,058.26

SOMERSET QUADRANGLE.

SOMERSET NORTHEAST ALONG BALTIMORE AND OHIO RAILROAD TO
RAILROAD CROSSING 1.10 MILES NORTHEAST OF GEIGER.

Somerset, south of, at road crossing, 150 feet east of railroad, on northwest abutment of iron highway bridge, top of bolt head; marked "2093,"	2,092.80
Somerset, in front of station; top of rail,	2,104.05
Somerset, in northeast corner of stone foundation wall of Baltimore and Ohio station, on east side; aluminum tablet stamped "2106-1908,"	2,105.618
Somerset, 0.99 mile northeast of, at road crossing, 30 feet east of railroad, 10 feet south of wagon road, 5 feet east of fence corner, point on rock; marked on post "B. M. 2129,"	2,129.11
Geiger, 300 feet south of station, west of railroad, 50 feet south of overhead highway bridge, in northwest corner of stone arch, under old South Pennsylvania Railroad, in fourth tier of arch above ground; aluminum tablet stamped "2207-1908,"	2,206.353

WINDBER QUADRANGLE.

FROM RAILROAD CROSSING 1.10 MILES NORTHEAST OF GEIGER
NORTHEAST ALONG BALTIMORE AND OHIO RAILROAD VIA
HOOVERSVILLE TO BORDER STATION.

	Feet.
Listie, in front of station; top of rail,	2,101.58
Wells Creek, 237 feet east of station, in north end of east abutment of railroad bridge over stream; aluminum tablet stamped "2054-1908,"	2,053.492
Quemahoning Junction, at junction with Boswell Branch of Baltimore and Ohio Railroad, 100 feet south of station sign, on east side of tracks, in base of switch lock, top of spike; marked "B. M. 2032,"	2,031.503
Friedens, in front of station, top of rail; marked "2038,"	2,027.36
Coleman, 60 feet south of station, 75 feet east of northeast corner of store and post-office kept by W. W. Dufall, 80 feet west of wagon road running east and west, in rock; aluminum tablet stamped "2016-1908,"	2,015.225
Mostoller, 0.8 mile north of, 15 feet west of railroad, on gray sandstone rock, point; marked "1849,"	1,848.67
Mostoller, 1.6 miles north of, 30 feet east of railroad, 200 feet north of milepost R. 21-J. 24, in sandstone rock; aluminum tablet stamped "1,810-1908,"	1,809.298
Stoyestown, 2.3 miles north of, 680 feet north of milepost R. 24-J. 21, 40 feet east of railroad, in large flat boulder; aluminum tablet stamped "1713-1908,"	1,712.420
Hooversville, in front of station; top of rail; marked "1679,"	1,678.39
Hooversville, 0.4 mile north of, in east end of north abutment of railroad bridge No. 230; aluminum tablet stamped "1667-1908,"	1,666.705
Landstreet, in front of station, top of rail; marked "1575,"	1,574.73
Landstreet, 380 feet north of station, 80 feet west of railroad, 95 feet northwest of milepost R. 30-J. 15, in north end of east abutment of highway bridge; aluminum tablet stamped "1572-1908,"	1,571.641
Landstreet, 1.1 miles northwest of, at milepost R. 31-J. 14, 30 feet south of milepost, point on rock; marked "B. M. 1557,"	1,556.39
Holsapple, 235 feet north of station, east end of south concrete abutment of railroad bridge No. 246; marked "B. M. 1535,"	1,534.55
Holsapple, 1.4 miles northeast of, 40 feet east of railroad, 415 feet south of Livingston Union Baptist Church, on north side of old road, in rock; aluminum tablet stamped "1505-1908,"	1,504.360
Border, in front of station; top of rail,	1,352.30
Border station, 422 feet north of station, in east end of south abutment of railroad bridge No. 252; aluminum tablet stamped "1351-1908,"	1,350.212

FROM FRIEDENS NORTHWEST ALONG RAILROAD AND COUNTY ROAD
TO BOSWELL, THENCE ALONG PUBLIC ROAD VIA JEROME TO
A POINT 2.70 MILES NORTHEAST OF THOMAS MILL.

Friedens, 3.1 miles northwest of, in south end of east abutment of stone arch under railroad, over wagon road, 100 feet northwest of oil derrick, in lower tier of stone; aluminum tablet stamped "1853-1908,"	1,852.440
Fiedens, 4.5 miles northwest of, west of railroad in cut, point on rock; marked "1997,"	1,996.33
Ralphton, 0.4 mile north of, 20 feet west of railroad, 300 feet west of Crist's farm, in sandstone culvert; aluminum tablet stamped "2016-1908,"	2,015.698
Critchfield Farm, at junction with turnpike running east and west, 70 feet east of three-corners, 30 feet north of barn, point on brown rock; marked "1918,"	1,917.53
Main road running north at cemetery, point on large flat rock in centre of forks; marked "2005.5,"	2,005.25
Critchfield Farm, 1.4 miles northwest of, at top of hill just east of Boswell, north of road, 226 feet west of road, running north, at graveyard, in sandstone outcrop; aluminum tablet stamped "2001-1908,"	2,000.997
Boswell, in front of Baltimore and Ohio station, top of rail; marked "1834,"	1,833.70
Boswell, on north end of west abutment of highway bridge over Quemahoning Creek, chiseled square; marked "1814,"	1,814.02
Junction with main road running east at signboard "Johnstown Pike 3 mi.—Davidsville 6 mi.," near foot of signboard, point on rock; marked "1877.5,"	1,877.19

	Feet.
Boswell, 2.0 miles northeast of, at crossroads at frame church, at northeast corner of crossroads, 50 feet west of southwest corner of church, in rock; aluminum tablet stamped "1896-1908,"	1,895.198
Boswell, 4.0 miles northeast of, at four corners, at signboard reading "Boswell 4 mi.—Johnstown Pike 1 mi.," at southeast corner of crossroads, at northwest corner of barn, point on oblong rock; marked "1904,"	1,904.11
Jerome, at east edge of town, 425 feet north of forks, east of road, in south foundation wall of Ira J. Moon's store; aluminum tablet stamped "1797-1908,"	1,796.377
Jerome, 1.8 miles north of, at junction with Johnstown turnpike, at Thomas' Mill, at signboard reading "Maple Spring Church 2 mi.," 50 feet north of forks, point on rock over mill-race; signboard marked "B. M. 1410,"	1,409.64
Thomas' Mill, 1.1 miles northeast of, west of road, in south foundation wall of church on south side; aluminum tablet stamped "1388-1908,"	1,388.019
Thomas' Mill, 2.7 miles northeast of, west of road, point on sandstone outcrop; marked "1810,"	1,810.14

FROM COLEMAN SOUTHEAST ALONG HIGHWAYS TO SHANKSVILLE,
THENCE NORTHEAST AND NORTH ALONG HIGHWAYS VIA
REITZ, ARROW AND WINDBER TO SCALP LEVEL.

Coleman, 3.5 miles southeast of, 690 feet east of forks, 30 feet north of road, on ground of Chas. Shank; in rock; aluminum tablet stamped "2225-1908,"	2,224.318
Shanksville, centre of town, 30 feet south of four corners, 10 feet west of southwest corner of large barn, on sandstone outcrop; chiseled square; marked "2227,"	2,227.05
Shanksville, 1.4 miles northeast of, west of road, 40 feet south of road running northeast and southwest, in hub on 36-inch maple tree, nail; marked "2518," (hub is old coal land survey bench mark),	2,517.29
Shanksville, 1.7 miles northeast of, 30 feet west of road, 200 feet southwest of house owned and occupied by L. L. Harding; aluminum tablet stamped "2481-1908,"	2,481.054
Shanksville, 2.8 miles northeast of, at junction with road running west, at southwest corner of forks, point on rock; marked "B. M. 2423,"	2,422.44
Buckstown, at southwest corner of crossroads, in east foundation wall of store kept by Daniel Wagner; aluminum tablet stamped "2428-1908,"	2,427.994
Buckstown, 1.2 miles northeast of, 60 feet east of junction with T shaped road, on south side of road, 8 feet east of spring, point on rock; fence marked "B. M. 2540,"	2,539.27
Forks of road, at west edge of woods, in hub on oak tree standing in centre of forks, nail; marked "T. P. 2551," (Coal Survey bench mark),	2,551.03
Road running east, point on old hub on 3-inch maple tree; marked "2427," (Coal Land Survey bench mark),	2,426.58
Buckstown, 3.3 miles northeast of, west of road, 35 feet north of road running east, in large sandstone rock; aluminum tablet stamped "2384-1908,"	2,383.328
Reitz, at forks of road, north of post-office, east of road, in large sandstone boulder shaped like a stone bench; aluminum tablet stamped "2139-1908,"	2,138.893
Reitz, 1.9 miles northwest of, at forks at top of divide, 30 feet south of forks, point on rock; marked "2340.5,"	2,340.24
Reitz, 3.2 miles northwest of, in south end of west abutment of highway bridge over Shade Creek; aluminum tablet stamped "1942-1908,"	1,941.320
Reitz, 5.6 miles north of, at Berwind-White's coal mine, 20 feet north of railroad crossing, west side, point on rock; marked "B. M. 2139,"	2,138.64
Arrow, at forks of road, at bridge north of, in rock on east side of road and 50 feet south of forks; aluminum tablet stamped "2043-1908,"	2,043.009
Ashtola, south end of town, 65 feet north of railroad crossing, west of wagon road, in root of 12-inch pine tree, nail; marked "2085,"	2,084.79
Rummel, front entrance to German Baptist (Dunkard) Church, in south end of third stone step from bottom; aluminum tablet stamped "1857-1908,"	1,856.679

	Feet.
Windber, 25 feet northwest of northwest corner of Grand Central Hotel, in south end, of east abutment of highway bridge over Paint Creek; aluminum tablet stamped "1683-1908,"	1,683.137
Scalp Level, 0.5 mile north of, 30 feet west of railroad, 75 feet southwest of toolhouse, in sandstone boulder; aluminum tablet stamped "1719-PITTS.,"	1,719.225

JOHNSTOWN QUADRANGLE.

BORDER STATION NORTHWEST ALONG BALTIMORE AND OHIO RAILROAD TO INGLESIDE.

Walsall station (Ingleside), in front of station platform; top of rail,	1,282.26
Walsall station (Ingleside), 0.2 mile north of station, in east end of north abutment of railroad bridge; bronze tablet stamped "1275-PITTS.,"	1,275.610

FROM A POINT 2.70 MILES NORTHEAST OF THOMAS' MILL NORTHEAST ALONG HIGHWAYS TO KRING, THENCE SOUTHEAST ALONG BALTIMORE AND OHIO RAILROAD TO INGLESIDE.

Thomas' Mill, 3.6 miles northeast of, at junction with road running northeast and southwest, east of road, 30 feet north of forks, point on rock; marked "1558,"	1,557.74
Thomas' Mill, 4.1 miles northeast of, east of road, west of creek, on ground of Wm. J. Sala, in large flat sandstone rock; aluminum tablet stamped "1527-1908,"	1,526.999
Thomas' Mill, 5.5 miles northeast of, 500 feet southwest of main forks at church and schoolhouse, east of road, point on rock; marked "1286,"	1,286.07
Kring, 30 feet west of station sign, south of small railroad bridge; top of rail section; marked "1241,"	1,240.88
Kring, 0.2 mile north of, on southeast end of culvert, chiseled square; marked "U. S. 1237," (old bench mark),	1,236.99

BELLEFONTE QUADRANGLE.

CENTRE COUNTY.

Elevations based upon the 1903 adjustment of precise leveling. Leveling in 1908 by H. M. Gillman, Jr., and Pennsylvania Railroad.

BELLEFONTE QUADRANGLE.

PENNSYLVANIA RAILROAD BENCH MARKS.

	Feet.
B. M. No. 18, on northwest foundation of water tank east of Curtain station; square,	649.34
B. M. No. 19, in northwest bridge seat of bridge 40; copper bolt,	670.68
B. M. No. 20, in northwest bridge seat of bridge 37; copper bolt,	664.56
B. M. No. 21, in southeast bridge seat of bridge 36; copper bolt,	682.65
B. M. No. 22, in southwest bridge seat of small bridge, 360 feet west of milepost 31-24; copper bolt,	697.26
B. M. No. 22a, 2,575 feet south of milepost 31-2, west side of track; on shelf of limestone rock,	703.55
B. M. No. 22b, 1,520 feet north of milepost 33-0, east side of track; on northwest bridge seat of county bridge; square,	721.81
B. M. No. 22c, at Bellefonte, on window sill of ticket office; on shelf,	749.37
B. M. No. 23, in northwest bridge seat of bridge 34; copper bolt, ..	706.46
B. M. No. 24, in southwest bridge seat of bridge 33 at Snowshoe intersection; copper bolt,	723.07
B. M. No. 25, in southeast bridge seat of bridge 31; copper bolt, ..	745.63
B. M. No. 26, in southwest bridge seat of bridge 30; copper bolt, ..	761.86
B. M. No. 27, at Unionville, in southeast bridge seat of bridge 27; copper bolt,	771.87
B. M. No. 28, in southwest bridge seat of bridge 25; copper bolt, ..	797.37
B. M. No. 29, 770 feet east of milepost 24-31, in northeast bridge seat of small bridge; copper bolt,	798.31
B. M. No. 30, in northwest bridge seat of bridge 24, copper bolt, ..	830.68

	Feet.
B. M. No. 31, at Julian, in southeast bridge seat of bridge 23; copper bolt,	848.10
B. M. No. 32, in southwest bridge seat of bridge 22; copper bolt, .	852.48
B. M. No. 33, in northwest bridge seat of bridge 21; copper bolt, .	879.87
B. M. No. 34, in northwest bridge seat of bridge 19; copper bolt, .	901.18

JULIAN SOUTHEAST ALONG HIGHWAY AND RAILROAD, TO STATE COLLEGE, THENCE EAST, TO LAMONT, THENCE NORTH ALONG RAILROAD, TO MILESBORO.

Julian, at North Julian, in southeast bridge seat; copper bolt, ...	848.100
Julian, 180 feet east of station, in southeast bridge seat of bridge 23 on Bald Eagle Valley Branch of Pennsylvania Railroad; aluminum tablet stamped "Prim. Trav.—850—1907,"	849.958
Julian, 2.2 miles southwest of, 2.0 miles north of Waddle, at west side of road at road forks, on rock; chisel mark,	1,618.37
Waddle, at southeast corner of road forks, in northeast corner of east face of large barn owned by D. L. Meek; aluminum tablet stamped "113-1908,"	1,112.934
Waddle, 3.0 miles southeast of, 4.9 miles northwest of State College, 510 feet north of railroad, in northeast corner of east face of foundation of barn owned by Geo. B. Thompson on Pondbank Farm; aluminum tablet stamped "1197-1908,"	1,196.855
State College, 3.5 miles northwest of, 10 feet south of tracks, at road crossing, on rock; chisel mark,	1,091.35
State College, in north face at northwest column base at east entrance to Engineering Building; aluminum tablet stamped "1154-1908,"	1,153.994
State College, 1.8 miles northeast of, 1.0 mile west of Lemont, on east side of road at T road to west, on rock; chisel mark,	964.30
Lemont, at southeast corner of road crossing opposite station, in southwest corner of northwest face of buttress of Lemont Presbyterian Church; aluminum tablet stamped "1046-1908,"	1,045.778
Peru station, 4.0 miles north of Lemont, 360 feet west of railroad, in north face of stone foundation of house owned by Wm. E. Crust; aluminum tablet stamped "1020-1908,"	1,020.241
Pleasant Gap station, 0.5 mile north of, 3.8 miles south of Bellefonte, 150 feet east of railroad, in southwest corner of west face of large stone house on pike owned (house) by Dr. R. G. Hayes of Bellefonte; aluminum tablet stamped "880-1908,"	879.640
Bellefonte, at intersection of Allegheny and High streets, at east side of Allegheny street, in southwest corner of west face in water tablet of courthouse; aluminum tablet stamped "809-1908,"	809.135
Milesburg, opposite station, on south side of road, in northwest corner of north face of residence of J. W. Peace; aluminum tablet stamped "700-1908,"	699.954

SNOWSHOE INTERSECTION NORTHWEST, TO RUNVILLE AND RETURN.

Runville, 500 feet west of station, in southwest abutment of bridge No. 57; aluminum tablet stamped "874-1908,"	873.571
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UNIONVILLE NORTHWEST, TO BELLEGROVE SCHOOLHOUSE AND RETURN.

Unionville, 240 feet west of road crossing, in northeast bridge seat of bridge No. 26; aluminum tablet stamped "Prim. Trav. Sta. No. 13—780—1907,"	779.984
Unionville, 2.1 miles northwest of, 0.5 mile southeast of road forks, in southeast face of stone foundation to Bellegrove schoolhouse; aluminum tablet stamped "1024-1908,"	1,023.892

JULIAN NORTHWEST, TO BELLEVIEW SCHOOLHOUSE AND RETURN.

Belleview schoolhouse, 2.0 miles northwest of Julian, 330 feet north of road forks, in centre of south face of schoolhouse; aluminum tablet stamped "1003-1908,"	1,002.750
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FAIRFIELD QUADRANGLE.

ADAMS COUNTY.

Elevations based upon the 1903 adjustment of precise leveling.
Leveling in 1908 by H. M. Gillman, Jr., and H. W. Peabody.

FAIRFIELD QUADRANGLE.

BIGLERSVILLE WESTERLY ALONG HIGHWAY, TO HILLTOWN,
THENCE SOUTH TO NEAR FAIRFIELD.

	Feet.
Biglerville, 1.0 mile west of, on rock on north side of road at T road to south; chiseled mark,	683.80
Biglerville, 1.9 miles west of, Clear Springs schoolhouse at northeast corner of crossroads, in centre of crossroads, on stone; chisel mark,	731.42
Arendtsville, at southwest corner of crossroads, in northwest corner of west face of Zion Reform Church; aluminum tablet stamped "710-1908,"	710.136
Arendtsville, 0.5 mile west of, Paradise schoolhouse at southeast corner of crossroads, on rock at southwest corner; chisel mark, ..	805.49
Arendtsville, 2.0 miles southwest of, on rock at northwest corner of road forks; chisel mark,	769.95
Hilltown, on flag stone in front of M. J. Miller's store at T road to south; chisel mark,	752.70
Cashtown, 170 feet west of T road south, in southeast corner of south face of Rocky Top Hotel; aluminum tablet stamped "745-1908,"	745.267
Orrtanna, 660 feet south of station, on east side of road, in northwest corner of west face of Orrtanna M. E. Church; aluminum tablet stamped "669-1908,"	669.719

NEAR FAIRFIELD EAST ALONG ROAD, TO GETTYSBURG.

Fairfield, 2.0 miles north of, on west side of road about 80 feet south of small stream crossing, on rock outcrop; chisel mark, ..	620.95
Fairfield, in southeast corner of east face of Lutheran Church; aluminum tablet stamped "608-1908,"	608.055
Fairfield, 3.0 miles east of, 400 feet north of road, in southeast corner of east face of old stone Church; aluminum tablet stamped "558-1908,"	558.025
Gettysburg, 3.0 miles west of, Old Black Horse Tavern, on rock at centre of road at T road to north,	492.68
Fairview schoolhouse, 2.5 miles west of Gettysburg, at northwest corner of road forks, in northeast corner of east face of schoolhouse; aluminum tablet stamped "527-1908,"	527.038
Gettysburg, 1.0 mile west of, at northwest corner of Reynolds avenue; on top of cannon ball,	556.01

APPENDIX D.

LIST OF COMPLETED TOPOGRAPHIC MAPS.

The annexed table represents the completed maps, which are published, and can be had from the United States Geological Survey. Others are in course of publication and will soon be issued.

Quadrangle.	Area mapped.
Accident (Md.-Pa.,-W. Va.),	25.86
Allentown,	226.73
Amity,	228.40
Andover (Pa.-Ohio),	17.60
Barnesboro,	226.73
Beaver,	226.73
Bedford,	228.40
Blair (Pa.-W. Va.),	26.00
Bellefonte,	225.90
Blacksville (W. Va.-Pa.),	26.28
Bloomsburg,	225.06
Bordentown (N. J.-Pa.),	2.82
Boyertown,	227.57
Brownsville,	228.40
Bruceton (W. Va.-Pa.),	26.61
Burgettstown,	227.57
Burlington (Pa.-N. J.),	138.50
Camden (N. J.-Pa.-Del.), ^a	209.73
Cameron (W. Va.-Ohio-Pa.),	17.60
Carlisle,	228.40
Carnegie,	227.57
Catawissa,	225.90
Chambersburg,	229.22
Chester (Pa.-Del.-N. J.), ^b	153.73
Clarion,	225.06
Claysville,	228.40
Coatesville,	229.22
Columbiana (Pa.-Ohio),	17.60
Conneaut (Pa.-Ohio),	16.00
Connellsville,	228.40
Curwensville,	225.90
Delaware Water Gap (Pa.-N. J.),	131.01
Doylestown (Pa.-N. J.),	207.10
Dundaff,	223.36
Easton (Pa.-N. J.),	80.18
Ebensburg,	227.57
Elders Ridge,	226.73
Elkland,	222.50
Elkton (Md.-Del.-Pa.),	28.50
Elmira (N. Y.-Pa.),	1.55
Erie,	114.61
Everett,	228.40
Fairfield,	229.22
Fairview,	22.92

a. Chester and Philadelphia sheets, on scale of 1:62,500, have been reduced, and form parts of Camden sheet, on scale of 1:125,000.

b. Philadelphia and vicinity sheet includes Chester, Germantown, Norristown and Philadelphia sheets.

Quadrangle.	Area mapped.
Flintstone (Md.-Pa.-W. Va.),	26.91
Foxburg,	225.06
Franklin,	224.21
Freeport,	226.73
Frostburg (Md.-W. Va.-Pa.),	26.37
Gaines,	222.50
Germantown (Pa.-N. J.), ^c	225.00
Gettysburg,	229.22
Girard,	219.50
Grantsville (Md.-Pa.),	25.86
Greensburg,	227.57
Hancock (W. Va.-Md.-Pa.),	25.37
Harrisburg,	227.57
Harvey Lake,	224.21
Havre de Grace (Md.-Pa.),	25.36
Hazleton,	225.90
Hollidaysburg,	227.57
Honesdale,	233.36
Honeybrook (Suplee),	227.40
Houtzdale,	225.90
Hummelstown,	227.57
Huntingdon,	227.57
Indiana,	226.73
Johnstown,	227.57
Kinsman (Pa.-Ohio),	17.60
Kittanning,	225.90
Lambertville (Pa.-N. J.),	49.86
Lancaster,	228.40
Latrobe,	227.57
Lebanon,	227.57
Linesville,	223.36
Littleton (W. Va.-Pa.),	1.95
Lykens,	228.73
Mahanoy,	225.90
Mannington (W. Va.-Pa.),	26.28
Masontown,	229.22
Mercersburg,	229.22
Middletown,	228.40
Millersburg,	226.73
Millerstown,	226.73
Morgantown (W. Va.-Pa.),	26.90
New Castle,	225.90
Neshannock,	225.06
New Bloomfield,	227.57
New Cumberland,	228.40
New Holland,	228.40
New Kensington,	226.73
Norristown, ^d	228.40
Oswego (N. Y.-Pa.),	1.29
Parkton (Md.-Pa.),	26.00
Patton,	226.73
Pawpaw (Md.-W. Va.-Pa.),	25.86
Philadelphia (Pa.-N. J.), ^e	56.00
Philadelphia and vicinity (Pa.-N. J.-Del.), ^f	623.13
Phoenixville,	228.40
Pinegrove,	226.73
Pittsburg,	227.57
Pittston,	224.21
Port Jervis,	6.00
Pottsville,	226.73
Punxsutawney,	225.90
Quakertown,	227.57
Reading,	227.57
Rogersville,	229.22
Rural Valley,	225.90
Scranton,	224.21
Sewickley,	226.75
Shamokin,	225.90

c. Philadelphia and vicinity sheet includes Chester, Germantown, Norristown and Philadelphia sheets.

d. Philadelphia and vicinity sheet includes Chester, Germantown, Norristown and Philadelphia sheet.

e. Chester and Philadelphia sheets on scale of 1:62,500, have been reduced, and form parts of Camden sheet, on scale of 1:125,000.

f. Philadelphia and vicinity sheet includes Chester, Norristown and Philadelphia sheets.

Quadrangle.	Area mapped.
Shenango,	224.21
Shickshinny,	225.06
Slatington,	226.73
Smicksburg,	225.90
Steubenville (Ohio-W. Va.-Pa.),	17.60
Sunbury,	225.90
Tioga,	225.50
Uniontown,	229.22
Wallpack (N. J.-Pa.),	52.50
Warren,	219.00
Waynesburg,	229.22
Wellsville (Ohio-W. Va.-Pa.),	17.69
Wernersville,	227.57
West Chester (Pa.-Del.),	165.55
Westminster (Md.-Pa.),	26.00
Wheeling (W. Va.-Ohio-Pa.),	17.60
Wilkes-Barre,	225.06
York,	229.22
York special,	75.33
Youngstown,	17.60
Zelienople, (Ohio-Pa.),	225.90

APPENDIX E.

PUBLICATIONS OF THE PENNSYLVANIA SURVEY AND OF THE UNITED STATES GEOLOGICAL SURVEY RELATING TO PENNSYLVANIA.

First Geological Survey of Pennsylvania;

Second Geological Survey of Pennsylvania.

The reports of these surveys have long been out of print and neither this survey or other departments of the State government have the same for distribution. They can generally be had from dealers in second hand books.

The publications of this survey are as follows:

GENERAL REPORTS.

Report of 1899 and 1900. A report of 135 pages with a progress map of the State, showing the results of the topographic work and also of the co-operative geological work.

Report of 1899-1906. A report of 308 pages with an index map of the topographic and co-operative geological work in the State. Contains a list of positions in the State determined by triangulation and by primary traverse, a list and description of meridian lines and magnetic determinations by the United States Geological Survey and by the Coast and Geodetic Survey, a list of determined elevations within the State, and a list of published topographic atlas sheets.

Report of 1906-1908. A report of 375 pages. Contains an index map of the State showing the location of completed topographic surveys and of geologic folios. A map showing the location of the various triangulation stations in the State and the quadrangles with primary traverse control. A map showing the lines of the precise level net within the State. A list of the triangulation stations and positions determined by primary traverse during the time covered by the report, and a list of completed topographic maps. The major portion of the volume is a geological report, giving a short account of the methods used by the United States Geological Survey within the State and the results of the co-operative geological work within the State, with 21 plates and 21 figures, by Dr. Geo. H. Ashley and others.

IN PRESS.

The Oil and Natural Gas Resources of the Sewickley Quadrangle. By M. J. Munn.

A detailed report on this subject in this quadrangle. This quadrangle has almost a hundred distinct oil and gas fields and pools, and the relation of structure to the various deposits, forms a most interesting chapter on this subject. Perhaps the best worked out structure of any oil and gas field in this country.

A Progress Map of Southwestern Pennsylvania. A map covering 25 quadrangles, showing the outcrop of the Lower Kittanning and Lower Freeport coals, with the area of the Pittsburgh coal shaded. The location and extent of the various oil and gas fields and pools and their relation to the structure, which is shown by contours on the horizon of the Pittsburgh coal over an area of about 6,000 square miles.

The Oil and Natural Gas Resources of the Clarion Quadrangle. By M. J. Munn. A report on the oil and gas development in this quadrangle similar to that of the Sewickley quadrangle above mentioned.

IN PREPARATION.

The Paint Ores of Pennsylvania. By Dr. Benj. L. Miller. A detailed report of the various ores of the State used in paint manufacture and of the industry dependent thereon.

The Tale and Turpentine of Eastern Pennsylvania. By Dr. Frederick B. Peck. A short account of these deposits, bringing the present information up to date. More than a preliminary report.

The Cement Industry of Lehigh and Northampton Counties. By Dr. Frederick B. Peck. An account of the cement materials and the industry in this great cement region. This will be much more than a preliminary report. This will be followed by other and fuller reports covering the entire State.

The Graphite Ores of Southeastern Pennsylvania. By Dr. Benj. L. Miller. A short report of this most interesting subject. The demand for information along this line makes this report most timely. It is the aim of the survey to cover other subjects of the same kind wherever the demand for information will justify.

All requests for reports or information relative to the work of the survey should be made to

GEORGE W. McNEES, Chairman,
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PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY.

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The following is a list of the publications now issued relating to Pennsylvania geology and all requests for the same should be made to

The Director, United States Geological Survey,
Washington, D. C.

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August 1st, 1910.

TOPOGRAPHIC AND GEOLOGIC SURVEY OF PENNSYLVANIA.

PAPERS ACCOMPANYING THE BI-ENNIAL REPORT OF THE COMMISSION
FOR THE
YEARS 1908-1909 and 1909-1910.

THE PRESENT STATUS OF NATURAL GAS DEVELOPMENT IN PENNSYLVANIA FIELDS.

By FREDERICK G. CLAPP.

The question is frequently asked whether the natural gas fields of Western Pennsylvania are practically exhausted, as many persons assume, or whether they may be depended upon to yield a good supply of gas for many years to come. The same question may be asked regarding oil, but gas particularly is considered here, since the maintenance of the supply of natural gas is a matter of greater importance to the inhabitants of the State. When Pennsylvania is considered together with West Virginia, the answer is easy; for the large companies supplying Pittsburg and other communities have pipe lines extending from Pittsburg far into the West Virginia fields, and they have extensive gas territory held in reserve, so there can be no failure of the supply as a whole for many years.

But there are some companies supplying cities of considerable size, as well as many manufacturing establishments, which have no lines to West Virginia, and must depend entirely upon local fields. What can be said regarding the continuance of the supply in these fields? It must be acknowledged that the outlook for the future of the fields has many discouraging aspects. The Pennsylvania fields are among the oldest gas fields in the country; and if they should follow the history of the northern Ohio, the northern Indiana, and certain other fields, but little future could be expected.

In most gas fields which have become largely exhausted, the cause of deficient supplies (except temporary deficiencies during excessively cold weather) has originated in the fact that gas has been assumed to

be inexhaustible, and has been used as if such were the case. In the northern Indiana and northern Ohio fields only a remnant of the supply of gas in the Trenton limestone now remains; most of the companies operating there are practically out of business (so far as the local supplies are concerned), and the few which remain in business have become greatly embarrassed to obtain sufficient gas to supply their consumers.

In the Kansas fields the supplies are declining, and factories are now being occasionally shut off from the supply in order to maintain sufficient gas to supply domestic consumers. It seems likely that the producers and consumers of natural gas in Oklahoma and Louisiana will profit by the experience of the older fields, and that unnecessary waste and extravagance will be avoided there to a greater extent than has been done elsewhere. This will be for the best interest of the companies, as the supply will thereby be maintained longer than in some older fields.

In Pennsylvania, West Virginia and southern Ohio the situation is somewhat different than in other states, on account of the greater number of separate fields of local extent, and of the deeper sands which are available to draw from when the shallow supplies fail. In nearly all these fields the exhaustion of the shallow sands, which were first tapped and utilized over twenty years ago, has been followed in time by a necessary raising of gas rates by the producers. In most cases this has resulted in protests on the part of the consumers, but such protests have usually failed to produce effect, for the courts called upon to make decisions have justly upheld the increase in rates by the companies. As a rule, the rates for natural gas in the early days were too low, and all cases of supplying it otherwise than by meter were deplorable mistakes. Perhaps the once common custom of furnishing certain classes of consumers with all the gas they could burn was, more than any other single factor, the cause of the unnecessary waste, which prevailed in these as in other fields. Some companies which formerly produced enough gas for their own needs and of their customers now have to purchase gas from other companies which are either wholesale dealers in natural gas or have a less number of consumers in proportion to their supply. The older fields in the Murrys ville, Butler, Fifth and other comparatively shallow sands have been practically exhausted for some years past.

Considering the discouraging conditions and the lamentable extravagance and wastefulness which once prevailed, the total production of gas inside the State holds out much better than might be expected. A careful analysis of the situation based on geological conditions and the status of the principal fields shows that the end of the gas supply from local fields is by no means yet in sight. In making

this statement the Pennsylvania fields as a whole are referred to. Certain individual fields have been exhausted, but others have taken their places to a considerable extent.

The possibility of maintaining the supply of natural gas is due to two factors: First, to the occasional discovery of new fields, and, second, to the discovery of new sands in the older fields. Pennsylvania, West Virginia and southern Ohio have the advantage not enjoyed by many fields, of containing scores of sandstone and limestone beds suitable for containing deposits of oil and gas, with overlying shale formations which hold the deposits in place. Judging from the history of the fields during the past few years, and more particularly from geological conditions and from operations during the past two years, a few new fields may still be discovered, although it seems probable that the productive territory has reached its maximum total area.

Prospecting for oil and gas in the eastern part of the western Pennsylvania and in some of the West Virginia fields has been pushed very close to the Allegheny mountains, with the result that several new productive fields have been opened up during the past two years. Geological examinations in that region show some chance still of increasing the productive territory and of adding some new fields to the list. Until within a few years the Chestnut Ridge anticline has been generally regarded as the eastern limit of profitable development. Certain small fields east of this will undoubtedly be found productive, but the territory for testing must be carefully chosen on the basis of geological conditions. The extreme types of structure, like the sharper crests of the larger anticlines and the regions of fracturing and severe folding must be avoided. At present the only important fields east of the Chestnut Ridge anticline are in West Virginia, and this is likely to continue so.

During the year 1909 an oil field was discovered in new territory near Shinnston, twenty miles south of the Pennsylvania line in West Virginia, between the Chestnut Ridge and Wolf Summit anticlines, several miles farther east than oil was supposed to exist. This field proved the best in these States since the early days of oil production, gushers being the rule, and from some of these several thousand barrels of oil per day were obtained. One well, according to reports, yielded about 4,000 barrels of oil per day, the largest production from a single well in the eastern fields for nearly twenty years. The total production of this field at its best was about 17,000 barrels per day.

The Steubenville pool, six miles from the Pennsylvania boundary, in Ohio, was also discovered and developed in 1909, and its daily production at one time ran considerably over 2,000 barrels. The Mingo, Ohio, pool and the Holiday's Cove, West Virginia pool, four and five miles respectively from the Pennsylvania boundary, date back only to 1908. As showing that gushers are not entirely relegated to the past,

even in Pennsylvania, several might be mentioned with initial production reported as high as 100 to 200 barrels of oil per day, obtained in 1909. But, as a rule, large oil wells are now struck as infrequently as large gas wells.

Some of the newer oil developments have taught a lesson which operators and geologists took years to learn, but now that it has been learned it is being productive of good results. This is the fact that when water is found in any sand it does not follow that all portions of that sand lying lower in the syncline also hold water or that they are destitute of oil or gas. This statement has been observed to be particularly true and significant in the Berea sand in Beaver county, Pennsylvania, in Hancock, Brooke, Ohio and Marshall counties, West Virginia, and in Columbiana, Jefferson and Carroll counties, Ohio. The condition undoubtedly holds true in many other counties and in other sands. Water also frequently occurs in abundance on the very crest of an anticline; for example, in the Dry Ridge field on the Fayette anticline in Westmoreland county, Pennsylvania, and on the Eureka-Volcano-Burning Springs anticline in West Virginia.

Water, when present, frequently occurs like oil and gas, in pools, dependent partly on the geological structure and partly on the internal character of the sands; and the oil and gas on a particular pool bear a definite structural relation to the contiguous pool or pools of water. In another place in the same sand, however, a pool of water and an associated pool of oil with its attendant gas may be found lower in the syncline. As an example of this statement may be mentioned certain fields in Beaver county, Pennsylvania, where there are some dry areas several miles in extent, which lie directly down-dip from important pools of oil or water, or both. For instance, near the corner of Brighton, Chippewa and South Beaver townships, in that county, is a small pool in which the production of the wells is so light that they are hardly worth pumping, producing at best only a barrel or two a day. This pool is bordered on the northeast, southeast and south by a number of strong salt water wells. Contrary to expectation of the operators, the pool was not found to lead to a stronger one nearby, the dips of the sand being too gentle to hold any strong accumulation. The water in close proximity to the pool occupies a definite structural relation with reference to the pool, occurring on all sides except the up-dip side. However, this accumulation of water was found not to extend far down-dip from the pool, as several wells between there and Ohio River, four miles southeast, were dry of both oil and water. Similar instances are found repeatedly in the Berea sand in this and neighboring counties, where dry sands occur on the down-dip sides of pools of oil and salt water. Therefore, the former theory that oil pools would not be found lower in a basin than areas of saturation in wet sands does not hold true.

Perhaps the most conspicuous example of the foregoing statement is along the Ohio River syncline and the Frederickstown anticline between Beaver county, Pennsylvania, and Belmont county, Ohio, where the lowest Berea sand oil pool in a given group of pools is successively higher in elevation going from southwest to northeast parallel to Ohio river. Near Wellsburg, Brooke county, West Virginia, some good gas wells are found in the Berea, where that sand is about 700 feet below the sea level. Near Mingo, Ohio, about three miles north of these wells, the lowermost elevation at which oil has yet been discovered is about 600 feet below sea level; at Steubenville it is about 500 feet below; at Holidays Cove, West Virginia, it is 400 feet below sea level; on the West Virginia-Pennsylvania line, near the southwest corner of Beaver county, it is 250 feet below; at Hookstown and Smith's Ferry, Beaver county, it is at sea level; while near Beaver Falls it is 300 feet above sea level. I understand that farther north, on the same anticline, oil has been discovered where sand is still higher. Also, I have no doubt that in Belmont county, Ohio, south and southwest of the gas wells mentioned near Wellsburg, productive oil and gas fields will be opened up where the Berea sand is still lower. Such unexpected developments as the foregoing, in territory where development and testing were once largely abandoned, seem to open some future for the Berea sand as a productive formation.

But the greatest prospect for the future development of natural gas lies in drilling to deeper sands. Within the past two years territory in the vicinity of many of the old fields which had become practically exhausted has been tested by drilling deeper, and many of the shallow wells in the old fields have been deepened, with the result that fields once productive from the Murrys ville, Butler and hundred-foot sands, where these are comparatively shallow, are now renewed in one or more of the Fifth, Bayard, Elizabeth, Speechley, Tiona, Bradford or Kane sands. In much territory where wells were formerly 1,100 to 1,500 feet deep, they are now averaging 3,000 to 3,500 feet. The Bradford sand seems to be the deepest sand yet reached in southwestern Pennsylvania, and this sand is productive in Westmoreland county as far south as the latitude of Pittsburg. Similar deep drilling is going on in West Virginia, but in that State the deepest productive sand known lies at about the position of the Fifth sand of Pennsylvania.

The fields in the deeper sands seldom correspond structurally with those in the shallow sands, and this is one reason why they are not discovered more rapidly. As a rule, the shallow sands are productive at or near the crests of an anticline, and are most often confined to domes in this crest, while the deeper sands are frequently dry on the crest, and more often productive on the flanks of the anticline where

it is dipping moderately fast towards the adjacent syncline. The deep sand pools which lie at some distance from the anticlinal crest generally take the longest to be discovered by the drill.

In most cases when the detailed geological structure of the surface formations and of the individual gas-bearing sands has been worked out, the discrepancy in positions of the deeper sands has been found due to nonparallelism or convergence of the formations. Geologists for many years have recognized the existence of an unconformity at the base of the Pottsville formation (salt sand) overlying the Burgoon sandstone (Big Injin sand), and sometimes cutting out the Big lime (Greenbrier limestone) entirely. They have even realized that this unconformity caused a structure in some of the lower sands which was somewhat different from the structure as they mapped it on the base of the Pittsburg coal bed or other datum. In the geology of Ohio, published in 1885, Edward Orton published a section showing that the Clinton sand in that State descended to the east at a rate stated to be twenty-six feet per mile faster than the surface strata. The first convergence map, so far as known, was published by the present writer in 1907 in bulletin 300 of the United States Geological Survey, giving the name, *isochore* lines to the contour-like lines denoting the amount of convergence between the Pittsburg bed and the hundred-foot sand. In Bulletin 304 of the United States Geological Survey, published the same year, Griswold first applied the name convergence sheet to the maps showing the amount of convergence.

The writer has found in subsequent examination of the oil and gas fields, that not only do the deeper sands show a somewhat different structure in their details than the surface strata, but every sand differs somewhat in structure from every other sand. Structure maps have been prepared of certain well-known fields, where as many as five maps showing the "lay" of different sands were prepared; all illustrating greater or less differences. As a rule, the discrepancies in structure are not great, and the positions of the anticlinal and synclinal axes in the different sands agree closely. But in all cases where the different sands were mapped the productive wells drilled to a particular sand were found to bear some definite relation to the geological structure, either to the anticlinal crest, to some abrupt change in degree of dip, or to a structural terrace. And nearly all dry holes were found due to the unsuitable geologic structure of the particular sand at the place. The remaining cases of dry holes were due to a change in character of the sand by which it was locally not of suitable texture to hold gas. This discovery seems destined to be of great importance, for it means an immense saving of dry holes in new fields developed if all the geological factors be taken into account. It also means that geology as applied to oil and gas development has passed beyond the stage of mere theory and has taken a place as a branch of

engineering. In future, the geological engineer is likely to be as necessary to a profitable prosecution of the oil and gas business as the consulting engineer is to any important branch of engineering construction.

In Ohio, too, deeper drilling is going on. In territory which has been previously tested as deep as the Berea and found barren or of slight value, wells have recently been drilled to the Clinton sand, and some fine pools of oil and gas have been opened up, with the result that developments in this sand are being rapidly pushed eastward, far beyond their original limits, and at present it seems as if the eastern extent of fields in that sand will be limited only by the depth to which it is possible to drill with present methods. The geological problems in connection with the occurrence of oil and gas in this sand are complicated by the fact that the Clinton sand is not even approximately parallel with any surface formation, nor is the rate of convergence uniform, as assumed by Orton, but the interval between the Clinton sand and the surface strata increases towards the east at a rate ranging from 30 to 100 feet per mile. That this increase continues at a similar rate as far as the Pennsylvania line is unlikely, and the possibilities in the development of the Clinton sand in this direction, as hinted at by Ohio developments, are worthy of consideration. The gas in the Clinton sand, like that in the Berea, seems to occur mainly on structural terraces, and on monoclinical changes in dip.

An important factor in considering the temporary limitations in depth of gas wells is that the deepest sand yet penetrated anywhere is southwest Pennsylvania, is little more than half way down the geological scale to the deeper oil-and-gas bearing formations of Ohio and Indiana. (This estimate takes into account the increase of intervals towards the east and south.) Finding the Fifth, Speechley, Tiona, Bradford, and other moderately deep sands productive in the old, shallow sand fields came as a sort of surprise to many operators because the deeper sands had different geological relations than were expected. These sands still have enormous acreage with favorable structure as yet untested. There seems no reason to suppose that the productive limits have yet been reached, or that the Corniferous, Niagara, Clinton and Trenton formations underlying western Pennsylvania are everywhere barren. Still deeper there is a possibility of gas existing in the contact zone between sedimentary and crystalline rocks, which has been found commercially productive at some places in Canada, and which also contains gas in northern New York State and elsewhere.

Some time in the future, with improved methods of drilling, it will pay to drill to these formations and they will be found productive in many places. What methods of drilling will eventually be used cannot be stated, but it seems reasonable to suppose that the present

cumbersome methods will in time be replaced by some radical departure, perhaps as yet unthought of. It seems almost certain that the string of tools and churn drill method as at present used will have to be abandoned in drilling extensively to depths of over a mile. With many wells still productive from the Berea, Hundred-foot, Fifth and Gordon sands, with drilling to the Speechley, Tiona and Bradford sands as yet in its infancy, and with almost unthought-of possibilities in the formations thousands of feet below, the ultimate disappearance of natural gas production from Pennsylvania is certainly many years distant.

What seems most essential at the present time is to point out the possibilities of deeper drilling, and the geological relations which may be expected in the untested strata.

A PRELIMINARY LIST OF THE FAUNA OF THE ALLEGHENY AND CONEMAUGH SERIES IN WESTERN PENNSYLVANIA.

By PERCY E. RAYMOND.

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A PRELIMINARY LIST OF THE FAUNA OF THE ALLEGHENY AND CONEMAUGH SERIES IN WESTERN PENNSYLVANIA.

By PERCY E. RAYMOND.

In the Allegheny Series there is, so far as is now known, only one horizon at which marine fossils may be obtained. The Vanport is usually a limestone, although in some places it is all shale. It is from 1 to 25 feet in thickness, and its base is usually about 250 feet below the top of the Allegheny series. It is very persistent in Pennsylvania west of the Chestnut Ridge and north of the latitude of Pittsburgh. Fossils are abundant at nearly all exposures, but good specimens can be obtained only where there are shaly layers. Only the more common and easily identified species are listed in the following tables:

Rochester, Pa., from outcrops along railroad between Rochester and New Brighton.

Productus nanus r,
Spirifer cameratus c,
Hustedia mormoni r,
Astartella varica r,
Bellerophon percarinatus r,

Trachydomia wheeleri c,
Naticopsis altonensis c,
Pleurotomaria carbonaria r,
Strophostylus remex r,
Orthoceras rushense r.

Beaver Falls, Pa., on bank above railroad one-half mile north of station.

Chonetes mesolobus c,
Derbya crassa r,

Squamularia perplexa r,
Soleniscus fusiformis r.

Wampum, Pa., limestone quarries on hills west of the town.

Campophyllum torquim r,
Thamniscus sevilensis r,
Productus semireticulatus r,
P. punctatus r,
P. nanus r,
Spirifer rockymontanus c,
S. cameratus r,
Squamularia perplexa c,
Hustedia mormoni r,
Cleiothyridina orbicularis c,
Composita subtilita r,

Composita girtyi c,
Dielasma bovidens r,
Acanthopecten carboniferous r,
Euomphalus catilloides r,
Porcellia peoriensis c,
Strophostylus remex c,
Naticopsis torta c,
Euconispira bicarinata c,
Pleurotomaria spironema c,
Endobolus missouriensis c,
Metacoceras sangamonensis r.

New Castle, Pa., old quarries of Green, Marquis and Johnson, between New Castle and New Castle Junction.

Fusulinella sp. r,
Cyathaxonia distorta c,
Septopora biserialis r,
Productus cora r,
P. punctatus r,
P. nanus c,
P. semireticulatus r,
Derbya crassa c,
Chonetes verneuillanus r,
C. mesolobus c,
Spirifer cameratus r,
S. rockymontanus c,
Spiriferina kentuckiensis r,
Squamularia perplexa c,
Cleiothyridina orbicularis c,
Hustedia mormoni c,
Dielasma bovidens c,
Composita subtilita r,
C. girtyi c,
Astartella varica c,
Acanthopecten carboniferous r,
Macrodon sangamonensis r,

Soleniscus fusiformis c,
Strophostylus remex c,
Anomphalus rotulus r,
Trachydomia wheeleri r,
Naticopsis torta c,
N. altonensis c,
Loxonema scitulum r,
Platyceras spinigerum r,
P. parvum r,
Bellerophon percarinatus r,
Patellostium montfortianum r,
Euomphalus catilloides r,
Porcellia peoriensis c,
Murchisonia terebra r,
Pleurotomaria spironema c,
P. granulostriata r,
Euconispira bicarinata r,
Glaphurochiton simplex r,
Domatoceras highlandense r,
Endobolus missouriensis c,
Orthoceras rushense r.

Kittanning, Pa., quarry in northern part of town.

Productus semireticulatus r,
Spirifer rockymontanus r,
Squamularia perplexa c,
Cleiothyridina orbicularis r,

Composita subtilita r,
C. girtyi r,
Strophostylus remex r,
Euconispira bicarinata r.

While there has not yet been enough collecting done to determine accurately the range of the various species in the upper part of the Pennsylvanian, it is probable that most of the common species have been noted. So far the following common species of the Vanport have not been seen at any higher horizon:

Fusulinella, sp.,
Cyathaxonia distorta,
Campophyllum torquim,
Chonetes mesolobus,
Productus nanus,
Spirifer rockymontanus,
Squamularia perplexa,
Dielasma bovidens,
Composita girtyi,

Astartella varica,
Pleurotomaria spironema,
Euconispira bicarinata,
Naticopsis torta,
N. altonensis,
Strophostylus remex,
Porcellia peoriensis,
Trachydomia wheeleri.

Of these species, *Spirifer rockymontanus*, *Chonetes mesolobus* and *Squamularia perplexa* are known to occur in the Mercer limestones of the Pottsville of western Pennsylvania, so they cannot be called strictly characteristic of the Vanport. Just what species are restricted to the Vanport will not be known until the fauna of the Mercer limestones is better known. Enough is at hand, however, to say that the fauna of the Vanport is much more like that of the Pottsville than it is like the fauna found in the various marine deposits of the Conemaugh.

THE CONEMAUGH SERIES.

Marine fossils are found at a number of horizons in the Conemaugh. In West Virginia there is a shale with a marine fauna at the base of

the series, but so far as the writer knows this shale does not occur in Pennsylvania. In this State the oldest marine fauna is found in the Brush Creek, about 100 feet above the base of the series.

THE BRUSH CREEK LIMESTONE.

The Brush Creek consists of both limestone and shale, the limestone usually very thin and impure, the shale fine grained and black. Fossils are usually abundant, and, in the shale, well preserved. The Brush Creek has an even greater extent than the Vanport as it is found from the Allegheny Front to the western border of the State, and has been recognized in Maryland, West Virginia and Ohio.

Bens Creek, Pa., a station on the Pennsylvania Railroad 96 miles east of Pittsburgh. The fossils were obtained in the first cut west of the station.

Chonetes verneuilanus c,
Derbya crassa c,
Productus nebraskensis r,
Nucula ventricosa c,
Yoldia carbonaria r,
Astartella vera c,
Sphaerodoma primogenia r,

Phanerotrema grayvillensis c,
Worthenia tabulata c,
Patellostium montfortanum c,
Bellerophon perearinatus r,
Bulimorpha nitidula r,
Goniatites lunatus r.

This locality is of some historical interest as the type locality of the first fossils described from the Coal-Measures of America, is only a hundred yards east of the station at Bens Creek. These first fossils, described by Conrad in 1835, are *Turbo tabulata* (*Worthenia tabulata*), *Stylifer primogenia* (*Sphaerodoma primogenia*), and *Turbo insectus*, a shell very similar to if not the same as *Pleurotomaria carbonaria*. The locality was described by Edward Miller in the Transactions of the Geological Society of Pennsylvania, Vol. I, p. 251, 1835, in an article entitled "A Geological Description of a Portion of the Alleghany Mountain: Illustrated by Drawings and Specimens." In regard to this particular locality Mr. Miller wrote: "The most interesting specimens found in this quarter are in a deep cutting at the head of inclined plane No. 3 (of the old Portage Railroad). A stratum of good coal (Gallitzin) two feet thick is found at this place, having a roof of black shale four feet thick, upon which is an unstratified bed of argillaceous rock containing a great variety of shells and other marine remains."

The fossiliferous layer is not at present exposed as the soft shales above it have crumbled down and covered it, but several loose fragments mingled with the talus showed that fossils may still be obtained there. The type of *Petalodus alleghaniensis*, described by Leidy in 1856, was also obtained at this locality.

Donohue, Pa. Fossils obtained from material excavated from cut on railroad one-half mile east of station and 36 miles east of Pittsburgh.

<i>Lophophyllum profundum</i> r,	<i>Bucanopsis marcouana</i> c,
<i>Lingula umbonata</i> r,	<i>Euphemus carbonarius</i> c,
<i>Productus cora</i> r,	<i>Patellostium montfortanum</i> c,
<i>Productus pertenuis</i> r,	<i>Worthenia tabulata</i> c,
<i>Marginifera wabashensis</i> c,	<i>Pleurotomaria carbonaria</i> c,
<i>Chonetes granulifer</i> r,	<i>P. perhumerosa</i> r,
<i>Derbya crassa</i> c,	<i>Phanerotrema grayvillensis</i> c,
<i>Derbya robusta</i> r,	<i>Trepostira illinoisensis</i> c,
<i>Spirifer cameratus</i> r,	<i>Bulimorpha nitidula</i> c,
<i>Ambocelia planoconvexa</i> r,	<i>Sphaerodoma primogenia</i> c,
<i>Composita subtilita</i> r,	<i>Dentalium meekianum</i> r,
<i>Nucula ventricosa</i> c,	<i>Euomphalus catilloides</i> c,
<i>Nuculana bellistriata</i> r,	<i>Orthoceras rushense</i> c,
<i>Yoldia carbonaria</i> c,	<i>Solenocheilus collectus</i> c,
<i>Acanthopecten carboniferous</i> r,	<i>Temnocheilus crassus</i> c,
<i>Astartella vera</i> c,	<i>Cyrtoceras curtum</i> r,
<i>Schizodus cuneatus</i> r,	<i>Goniatis lunatus</i> r,
<i>Bellerophon percarinatus</i> c,	<i>Petalodus ohioensis</i> r.

Blackburn, Pa., along a branch of the Pennsylvania Railroad between North Trafford and Murrysville.

<i>Lophophyllum profundum</i> r,	<i>Bellerophon percarinatus</i> c,
<i>Cerriocrinus</i> sp. r,	<i>Bucanopsis marcouana</i> c,
<i>Derbya crassa</i> c,	<i>Patellostium montfortanum</i> c,
<i>Chonetes granulifer</i> r,	<i>Euphemus carbonarius</i> c,
<i>C. verneuillanus</i> r,	<i>Worthenia tabulata</i> r,
<i>Productus cora</i> r,	<i>Pleurotomaria carbonaria</i> c,
<i>P. pertenuis</i> r,	<i>Trepostira illinoisensis</i> c,
<i>P. nebraskensis</i> c,	<i>Phanerotrema grayvillensis</i> c,
<i>P. punctatus</i> r,	<i>Sphaerodoma primogenia</i> c,
<i>Spirifer cameratus</i> c,	<i>Soleniscus ventricosus</i> r,
<i>Ambocelia planoconvexa</i> r,	<i>Bulimorpha nitidula</i> c,
<i>Composita subtilita</i> c,	<i>Platyceras parvum</i> r,
<i>Nucula ventricosa</i> c,	<i>Temnocheilus crassus</i> r,
<i>Nuculana bellistriata</i> r,	<i>Temnocheilus winslowi</i> r,
<i>Yoldia carbonaria</i> c,	<i>Solenocheilus collectus</i> r,
<i>Astartella vera</i> c,	<i>Orthoceras rushense</i> r,
<i>Macrodon obsoletus</i> r,	<i>Cyrtoceras curtum</i> r,
<i>Schizodus cuneatus</i> r,	<i>Griffithides scitulus</i> r,
<i>Deltopecten occidentalis</i> r,	<i>Deltodus angularis</i> r,
<i>Acanthopecten carboniferous</i> r,	<i>Petalodus ohioensis</i> r.
<i>Allorisma subcuneatum</i> c,	

Wittmer, Pa., on the Baltimore and Ohio Railroad, one mile south of Glenshaw.

<i>Lophophyllum profundum</i> r,	<i>Astartella vera</i> r,
Columns and plates of Crinoids,	<i>Allorisma subcuneatum</i> r,
<i>Productus nebraskensis</i> r,	<i>Pleurotomaria carbonaria</i> c,
<i>Marginifera wabashensis</i> r,	<i>Worthenia tabulata</i> c,
<i>Spirifer cameratus</i> c,	<i>Trepostira illinoisensis</i> r,
<i>Ambocelia planoconvexa</i> r,	<i>Bulimorpha nitidula</i> r,
<i>Composita subtilita</i> c,	<i>Platyceras parvum</i> r,
<i>Derbya crassa</i> c,	<i>Griffithides scitulus</i> .

In the fauna of the Brush Creek the mollusca predominate, the gastropoda being especially abundant. Only one common species, *Worthenia tabulata*, seems to be confined to this horizon, but it is generally abundant and has been found at every locality at which the writer has seen this stratum. In this connection it is interesting to note that

this is one of the few species of Pennsylvanian shells originally described from this State, and that the type came from this stratus at Bens Creek. As will be seen on the table giving the range of species, there are several other shells which have so far been found only in the Brush Creek, but these are mostly rare forms, and so are not particularly useful in identifying the horizon. Mention may be made of *Bucanopsis marcoviana*, which is quite common, but this shell is probably not confined to this horizon. "*Cyrtoceras*" *curtum* seems to be restricted to this layer, and though not common, it has been found at a number of localities. The great abundance of the four Bellerophons, *Astartella vera*, *Euomphalus cattilloides*, and the presence of *Worthenia tabulata* are the characteristics of this horizon. It will be noted that the smooth-shelled nautiloid of this stratum is a *Solenocheilus* instead of an *Endobolus* as in the Vanport, and that the robust *Sphaerodomus* take the place of the fusiform *Solenisci* of the lower formation. *Marginifera wabashensis*, *Chonetes granulifer*, and *Ambocoelia planoconvexa*, three species which are very common at higher horizons, make their first appearance here. Altogether there is a very great change of fauna between the Vanport and the Brush Creek.

Dr. Martin evidently found this same fauna in Maryland, as is shown by the following list of the species collected by him at a locality one mile north of Selbysport, Garrett county, Md. The list is published on p. 280, in Vol. II of the West Virginia Geological Survey.

Phillipsia sangamonensis,
Orthoceras sp.,
Temnocheilus sp.,
Worthenia tabulata,
Pleurotomaria sp.,
Macrocheilus sp.,
Bulimorpha sp.,
Euomphalus cattilloides,
Bellerophon percarinatus,
Euphemus carbonarius,

Allorisma subcuneatum,
Astartella vera,
Yoldia carbonaria,
Nucula ventricosa,
Productus nebraskensis,
Chonetes mesolobus,
Derbya crassa,
Composita sp.,
Eupachyerinus moorsei,
Zaphrentis sp.

In this list the characteristic species are present, the only unexpected species being *Chonetes mesolobus*, which, in Pennsylvania, has not yet been found above the Vanport.

PINE CREEK LIMESTONE.

From 60 to 90 feet above the Brush Creek is another fossiliferous layer of somewhat wide distribution. While fossils are often abundant in the Pine Creek, the writer has so far found only a few localities where good specimens can be obtained, and these are all near Pittsburgh.

Wittmer, Pa., on the Baltimore and Ohio Railroad, one mile south of Glenshaw.

Lophophyllum profundum c,
Rhombopora nickelsi c,
Septopora biserialis r,
Derbya crassa c,
Chonetes verneuillanus r,
Productus cora c,
P. nebraskensis r,
P. semireticulatus c,
Spirifer cameratus c,
Ambocœlia planoconvexa r,

Composita subtilita c,
Bulimorpha nitidula r,
Platyceras parvum r,
Pleurotomaria carbonaria c,
Bellerophon percarinatus r,
Euphemus carbonarius r,
Temnocheilus winslowi r,
Orthoceras rushense c,
Goniatites lunatus r,
Petalodus ohioensis r.

Powers Run, Montrose, Pa., old quarry near mouth of the run.

Lophophyllum profundum c,
Cerioerinus craigi r,
Orbiculoidea missouriensis r,
Derbya crassa c,
Chonetes verneuillanus c,
Productus cora c,
P. nebraskensis c,
P. semireticulatus c,
Spirifer cameratus c,
Spiriferina kentuckiensis r,
Ambocœlia planoconvexa c,

Composita subtilita c,
Cleiothyridina orbicularis r,
Nucula ventricosa r,
Nuculana bellistriata r,
Edmondia aspenwallensis r,
Allorisma subeuneatum c,
Patellostium montfortanum r,
Orthoceras lasallense r,
Solenocœilus collectus r,
Petalodus ohioensis r.

Allegheny, Pa., beside railroad three-fourths of a mile north of the Woods Run Station.

Lophophyllum profundum c,
Derbya crassa r,
Chonetes verneuillanus r,
Productus cora r,
P. nebraskensis r,
Spirifer cameratus c,
Ambocœlia planoconvexa r,
Composita subtilita c,
Nucula ventricosa r,
Allorisma subeuneatum c,

Macrodon tenuistriatus r,
Bulimorpha nitidula r,
Trepostira illinoisensis r,
Pleurotomaria carbonaria r,
Temnocheilus crassus c,
T. winslowi r,
Solenocœilus collectus c,
Orthoceras rushense r,
Griffithides seitulus r.

Stoops Ferry, Pa.

Glaphurochiton carbonarius r,
Trepostira illinoisensis c,

Temnocheilus winslowi r.

While there are a few species which seem to be restricted to the Pine Creek, it has no such marked characteristic species as the Brush Creek and the Vanport have. In almost every locality where fossils have been collected from this layer nautilloids have been found to be numerous, but not well preserved. The fauna is more like that of the Brush Creek than the Ames, but lacks the abundance of *Worthenia tabulata* and *Astartella vera* of the one and the *Chonetes granulifer* and *Tainoceras occidentale* of the other.

WOODS RUN LIMESTONE.

In a note in Science (n. s. Vol. XXIX, p. 940, 1909), the writer announced the presence in the section at Pittsburgh of a previously unnoticed marine limestone between the Pine Creek and the Ames. To

this limestone the name Woods Run may be applied, as it is well exposed on Woods Run within the city of Allegheny. Since the note mentioned above was published the writer has found this layer at Sharpsburg on the Allegheny River, near Boston, on the Youghiogheny, and at McKees Rocks. A few fossils are rather common in this layer, but the number of species is small.

Allegheny, Pa. Various outcrops on Woods Run, California avenue and Brighton road.

Lophophyllum profundum c,
Columns of Crinoids,
Productus pertenuis r,
P. nebraskensis r,

Derbya crassa r,
Spiriferina kentuckiensis r,
Diplodus compressus r.

Lophophyllum is the most common and often the only fossil found.

AMPHIBIA AND REPTILIA.

In the red clay which always underlies the Ames in western Pennsylvania the writer found the following species in 1907. The locality is beside the highway one mile west of Pitscain, Pa.

Desmatodon hollandi Case,
Eryops sp.,

Naosaurus? *raymondi* Case,
Undetermined reptilian bones.

Nearly all the specimens were found imbedded about 30 feet below the Ames limestone. The bones were all small and belonged to many different individuals. They were evidently washed into the position they occupied when found. They were found near the base of the red clay at a place where this clay is unusually thick, that is, they were in one of the basins in the eroded land surface on which this clay was deposited.

AMES LIMESTONE.

About 125 feet above the Pine Creek and 300 feet above the base of the Conemaugh is the Ames, one of the most persistent and most fossiliferous of the marine limestones. Fossils are everywhere abundant in this stratum, but it is only under favorable conditions that any variety of species can be obtained. In almost all the localities where this limestone is seen it is a mass of specimens of *Chonetes granulifer*, *Ambocoelia planoconvexa*, and *Derbya crassa*, while other fossils are not apt to be seen unless the rock is considerably disintegrated.

Summerhill, Pa., in a small cut on the Pennsylvania Railroad, 88 miles east of Pittsburgh.

Chonetes granulifer c,
Productus pertenuis c,
Ambocoelia planoconvexa c,
Nucula ventricosa r,
Euomphalus catilloides c,
Sphaerodoma texana r,

Euphemus carbonarius r,
Patellostium montfortanum c,
Platyceras parvum r,
Glaphurochiton carbonarius r,
Temnocheilus sp.

This locality is somewhat unusual because of the abundance of *Productus pertenuis*.

Blairsville Intersection, Pa., a small quarry one-fourth mile west of the station.

Chonetes granulifer c,
Ambocoelia planoconvexa c,

Derbya crassa c.

Beatty, Pa., a cutting on the Pennsylvania Railroad, one mile west of the station.

Chonetes granulifer c,
Derbya crassa r,
Producta cora r,

Ambocoelia planoconvexa c,
Pugnax utah c.

In the last two localities fossils are very abundant and further search would doubtless bring to light many more species.

Pitcairn, Pa., outcrops along the highway one mile west of the station.

Lophophyllum profundum c,
Chonetes granulifer c,
Derbya crassa c,
Marginifera wabashensis c,
Productus cora c,
P. semireticulatus c,
Pugnax utah c,
Hustedia mormoni c,
Rhipidomella pecosi c,
Spirifer cameratus c,
Ambocoelia planoconvexa c,

Composita subtilita c,
Macrodon obsoletus r,
Deltopecten occidentalis r,
Euomphalus catilloides r,
Euphemus carbonarius c,
Bellerophon percarinatus c,
Soleniscus ventricosus c,
Spharodoma texana c,
Pleurotomaria carbonaria r,
Tainoceras occidentale c,
Deltodus angularis r.

Pittsburg, Pa., a cut on the Brilliant cut-off of the Pennsylvania Railroad, near the Brilliant pumping station.

Lophophyllum profundum c,
Hydreinocrinus sp.,
Cerioerinus sp.,
Crania modesta r,
Orbiculoidea convexa r,
Rhipidomella pecosi c,
Derbya crassa c,
D. robusta r,
Chonetes granulifer c,
Productus cora c,
P. semireticulatus c,
P. nebraskensis r,
P. pertenuis r,
Marginifera wabashensis c,
Spirifer cameratus c,
Spiriferina kentuckiensis r,
Ambocoelia planoconvexa c,
Pugnax utah c,
Hustedia mormoni c,
Composita subtilita c,
Astartella vera r,
Edmondia aspenwallensis r,

Pseudomonotis hawni r,
Macrodon obsoletus r,
Euomphalus catilloides c,
Loxonema plicatum r,
Pleurotomaria carbonaria r,
Patellostium montfortanum c,
Euphemus carbonarius c,
Bellerophon percarinatus c,
B. stevensanus r,
Soleniscus ventricosus c,
S. paludinæformis c,
Spharodoma texana c,
Glaphurochiton carbonarius c,
Orthoceras rushense c,
Tainoceras occidentale c,
Temnocheilus crassus r,
T. winslowi r,
Fissodus inaequalis r,
Deltodus angularis r,
Cladodus occidentalis r,
Agassizodus variabilis r,
Petalodus ohioensis c.

The characteristics of the Ames are the abundance of *Chonetes granulifer*, *Ambocoelia planoconvexa* and *Derbya crassa*, and the presence of *Pugnax utah*, *Rhipidomella pecosi*, and *Tainoceras occidentale*. *Pugnax utah* and *Rhipidomella pecosi* seem to be restricted to this horizon and *Tainoceras occidentale* makes its first appearance here. Fish teeth are fairly common, *Petalodus ohioensis* being the

most common species. Brachiopods are particularly numerous in the Ames, just as gastropods and pelecypods predominate in the Brush Creek. Brachiopods are very abundant in the Vanport, but the two limestones have only a few species in common.

There are very few published lists of the fossils of the Ames limestone. A classical one is that identified by Meek from fossils collected at Morgantown, West Virginia.* This list shows that the fauna at Morgantown is very similar to that listed above.

In the report on Ohio, Brooke and Hancock counties of West Virginia is a list of the fossils collected by Professor Grimsley from the Ames in those counties. The following are the species, as identified by Dr. Beede:

Lophophyllum profundum,	Productus splendens,
Fistulipora sp.,	Hustedia mormoni,
Chonetes granulifer,	Rhipidomella pecosí,
Derbya crassa,	Pugnax utah,
Productus cora,	Composita subtilita,
P. semireticulatus,	Spiriferina kentuckiensis,
P. nebraskensis,	Ambocœlia planoconvexa.
Spirorbis cf. S. anthracosia,	

Commenting on this fauna, Dr. Beede discussed the probable position of the Ames in relation to the section in Kansas. While noting that most of the species listed are those which have a long range in the Pennsylvania section of that state, he is inclined to place the Ames at about the horizon of the Oread limestones, or as he says: "From the evidence at hand I should refer the Ames limestone roughly to the Shawnee division of the Kansas Pennsylvanian, as that division is limited by Haworth, or the basal part of the Shawnee."

Mr. D. Dale Condit has recently published a short list of the fossils of the Ames limestone at Carpenter, Meigs county, Ohio.†

The list is:

Lophophyllum profundum?	Productus pertenuis?
Chonetes granulifer,	Spirifer cameratus,
Productus cora,	Spiriferina kentuckiensis,
P. costatus,	Ambocœlia planoconvexa,
P. semireticulatus,	Petalodus destructor.

This list shows that the fauna of the Ames at this place is very similar to that found in western Pennsylvania. Mr. Condit notes that *Chonetes granulifer* is so abundant as to form almost solid masses in the Ames, but is not found in the Cambridge, while *Chonetes verneuili-anus* is extremely abundant in the Cambridge and is not found in the Ames. In Pennsylvania *C. verneuili-anus* has not yet been found in the Ames while it does occur in the Pine Creek and Brush Creek. On the other hand, *C. granulifer* does occur, although rarely, in the Brush Creek.

* Third Annual Report of the Board of Regents of West Virginia University, 1870, p. 67. Reprinted in West Virginia Geological Survey, Vol. II, 1903, p. 257, and in the County Reports of the same survey, 1907, p. 127.

† The Ohio Naturalist, Vol. IX, 1909, p. 485.

BIRMINGHAM SHALE.

Thirty feet above the Ames is the base of the Birmingham, a shale which is usually from 35 to 50 feet thick. It has recently been discovered that this shale contains marine fossils.‡

At the base of the formation is a coal which in the region west of Pittsburgh is usually identified as the Elk Lick, though the Elk Lick is really just below the Morgantown sandstone and 60 to 75 feet higher in the series than this coal. To this lower coal the name Duquesne may be applied as it is well developed along the Monongahela River north of that town. The shale above the coal usually contains plant stems, fragments of ferns, *Estherias*, and fish teeth (*Diplodus*).

Duquesne, Pa., along the Union Railroad below Kennywood Park.

At this locality crinoid columns, an undetermined gastropod, and a *Chonetes* were found in a nodule of limestone about 10 feet above the Duquesne coal. Near the top of the shale at the same locality the following fossils are quite plentiful:

<i>Productus cora</i> c.	<i>Edmondia aspenwallensis</i> c.
<i>P. semireticulatus</i> r.	<i>Nucula ventricosa</i> c.
<i>Allorisma subcuneatum</i> c.	<i>Acanthopecten carboniferous</i> r.
<i>A. costatum</i> r.	<i>Sphaerodoma</i> sp.
<i>Cardiomorpha missouriensis</i> r.	<i>Tainoceras occidentale</i> r.

The writer has found fossils at the top of this shale at various points from Riverview Park, Allegheny, to Glassport on the Monongahela above McKeesport, but the specimens are most common and best preserved at Kennywood Park, East Pittsburgh, and Wilmerding.

Summerhill, Pa., second cut east of the station and 89 miles east of Pittsburgh.

In this cut the Birmingham is well exposed and consists of dark gray sandy shales with a carbonaceous layer at the base. In the lower part of the formation fragments of ferns are quite common and a single wing of an insect was found. From the upper part a small number of specimens of a new species of *Orbiculoidea* (*O. planodisca*) were obtained. The interest in these specimens lies, of course, in demonstrating the marine origin of these shales at a point some 75 miles from the place where marine fossils were first found in them.

Summary.

In the table given at the end of this paper there are listed 97 species of invertebrate fossils. Of these 17 are found in both the Allegheny and Conemaugh series, 28 are found in the Allegheny series only, and 52 are restricted to the Conemaugh. If larger collections had been

‡ Science, n. s., Vol. XXIX, p. 940, 1909.

made and a greater area covered it is probable that these figures would have been materially altered, but it must be admitted that they indicate a great faunal change between the two series. Considering the three highly fossiliferous limestones of the Conemaugh, the Brush Creek, the Pine Creek and the Ames, it will be noticed that of the 67 species found in the three, 36 are found in at least two of them and 19 are common to all. In this connection the list of fossils identified by Meek from specimens collected by Dr. Stevenson from the Uffington shale near Morgantown, West Virginia, is of interest. The Uffington is at a horizon lower in the Conemaugh than the Brush Creek as it rests directly upon the Upper Freeport coal.

Productus cora,
P. nebraskensis,
Productus sp.,
Derbya sp.,
Spirifer cameratus,
Ambocoelia planoconvexa,
Composita subtilita,
Edmondia aspenwallensis,
Schizodus sp.,
Yoldia carbonaria,
Y. stevensoni,
Nuculana bellistriata,
Nucula ventricosa,
Allorisma sp.,
Acanthopecten carboniferous.

Aviculopecten sp.,
Astartella sp.,
Bellerophon percarinatus,
Euphemus carbonarius,
Bucanopsis meekana,
Patellostium montfortanum,
Euomphalus catilloides,
Polyphemopsis peracutus,
Soleniscus ventricosus,
Sphaerodoma primogenia,
Phanerotrema grayvillensis,
Orthoceras cribosum,
Tainoceras occidentale,
Phillipsia sangamonensis.

This is a strictly Conemaugh fauna, although directly at the base of the series. None of the species characteristic of the Vanport are present.

From the range of the individual species but little can be learned. It is a well known fact that *Chonetes mesolobus* is confined to the lower portion of the Pennsylvania in Kansas and elsewhere, and this proves to be true in Pennsylvania. In our collections there are, however, a number of species whose range terminates with that of *Chonetes mesolobus*, but which, in Kansas, extend much higher in the section than does that species. Thus, in Kansas, *Squamularia perplexa* extends to the Hartford limestone, *Dielasma bovidens* to the Burlingame shale, *Naticopsis altonensis* to the Howard limestone, and *Trachydomia wheeleri* to the Lecompton limestone. On the other hand it seems that three of the species of the Conemaugh, *Chonetes granulifer*, *Productus pertenuis*, and *Derbya robusta*, have not been found in Kansas lower than the Lecompton limestone. *Pugnax utah*, *Rhipidomella pecosi*, *Ambocoelia planoconvexa*, *Worthenia tabulata*, and *Phanerotrema grayvillensis* seem to have a much wider range in the section in Kansas than is yet known for them in Pennsylvania, where they are characteristic of the Conemaugh. On the basis of such meager evidence as this it is very unsafe to venture any definite correlations, but it seems possible that the horizons of the Vanport and Parsons limestones approximately correspond, and that the limestones of the Conemaugh were deposited at about the same time

as the Lecompton and some of the limestones above it. The limestones between the Parsons and the Lecompton would then represent the time interval between the Vanport and the base of the Conemaugh in Pennsylvania. This would account for the abrupt change of faunas in Pennsylvania, while in Kansas the more nearly continuous marine conditions permitted a more gradual transition between the two faunas. The center of distribution of these Pennsylvanian faunas was undoubtedly in the region now occupied by the Mississippi Valley, and for that reason we should expect each species to appear in Kansas at an earlier date than in Pennsylvania. Therefore I am inclined to place the Ames slightly higher than the Oread limestone.

It is to be regretted that there are no more faunal lists with which to compare those here presented. Lists showing the range of the species in Ohio, Kentucky, Indiana, and Illinois might throw a great deal of light on the correlation of the coal measures of these states.

ILLUSTRATIONS.

The four plates appended illustrate some of the more characteristic of the species mentioned in this article. All but three of the illustrations are reproductions of figures published in the Annals of the Carnegie Museum, and our thanks are due the Director, Dr. W. J. Holland, for his kindness in allowing us to use them. The figures are nearly all from photographs made by Mr. Louis Coggeshall of the Carnegie Museum, and all the specimens figured are in that Museum. The figures of *Ceriocrinus craigi* and *Productus nebraskensis* are new.

Table Showing Distribution of Known Fauna.

Name.	Vanport.	Brush Creek.	Pine Creek.	Woods Run.	Ames.	Birmingham.
Fusulinella sp.,	X					
Lophophyllum profundum (Milne-Edwards & Haime),		X	X	X	X	
Campophyllum torquim (Owen),	X					
Cyathaxonia distorta Worthen,	X					
Cerioerinus craigi (Worthen),		X	X			
Cerioerinus sp.,		X				
Hydreionocrinus sp.,					X	
Columns and plates of crinoids,	X	X	X	X	X	X
Septopora biserialis (Swallow),	X		X			
Thamniscus sevilensis Ulrich,	X					
Rhombopora Nicklesi Ulrich,		X	X			
Lingula umbonata Cox,		X				
Orbiculoidea missouriensis (Shumard),			X			
O. convexa (Shumard),					X	
O. planodisca Raymond,						X
Crania modesta White and St. John,					X	
Rhipidomella pecosi (Marcou),					X	
Derbya crassa (Meek and Hayden),	X	X	X	X	X	
Chonetes mesolobus Norwood and Pratten,	X					
C. verneuillanus Norwood and Pratten,	X	X	X			
C. granulifer Owen,		X	X		X	
Productus semireticulatus (Martin),	X	X	X		X	
P. cora d'Orbigny,	X	X	X		X	X
P. nebraskensis Owen,		X	X	X	X	X
P. punctatus (Martin),	X	X				
P. Nanus Meek and Worthen,	X					
P. pertenuis Meek,		X			X	
Marginifera wabashensis (Norwood and Pratten),		X	X		X	
Spirifer rockymontanus Marcou,	X					
S. cameratus Morton,	X	X	X		X	
Spiriferina kentuckiensis (Shumard),	X		X	X	X	
Squamularia perplexa (McChesney),	X					
Ambocoella planoconvexa (Shumard),		X	X		X	
Composita subtilita (Hall),	X	X	X		X	
C. girtyi Raymond,	X					
Cleothyridina orbicularis (McChesney),	X		X		X	
Dielasma bovidens (Morton),	X				X	
Hustedia mormoni (Marcou),	X				X	
Pugnax utah (Marcou),		X			X	
Dellopecten occidentalis (Shumard),	X	X	X			X
Acanthopecten carboniferous (Stevens),						
Pseudomonotis hawni (Meek and Hayden),					X	
Yoldia carbonaria Meek,		X				
Nuculana bellistriata (Stevens),		X	X			
Nucula ventricosa Hall,		X	X		X	
Edmondia aspenwallensis Meek,			X		X	X
Allorisma subuneatum Meek and Hayden,			X		X	X
A. costatum Meek and Worthen,						X
Schizodus cuneatus Meek,		X				
Macrodon sangamonensis Worthen,	X					
Macrodon tenuistriatus Meek and Worthen,			X			
Macrodon obsoletus Meek,					X	
Astartella varica McChesney,	X					
A. vera Hall,		X			X	
Cardiomorpha missouriensis Shumard,						X
Platyceras parvum (Swallow),	X	X	X		X	
P. spinigerum Worthen,	X	X				
Euomphalus catilloides (Conrad),	X	X	X		X	
Naticopsis altonensis McChesney,	X					
N. torta (Meek),	X					
Trachydontia wheeleri (Swallow),	X					
Bulimorpha nitidula (Meek and Worthen),		X	X			
Trepostira illinoisensis (Worthen),		X	X			
Worthenia tabulata (Conrad),						
Phanerotrema grayvillensis (Norwood and Pratten),		X				
Euconispira bicarinata (McChesney),	X					
Pleurotomaria spironema Meek and Worthen,	X					
P. carbonaria Norwood and Pratten,		X			X	
P. granulostriata Meek and Worthen,	X					
P. perhumerosa Meek,		X				
Murchisonia terebra White,	X					

TABLE SHOWING DISTRIBUTION OF KNOWN FAUNA—Continued.

Name.	Vanport.	Brush Creek.	Pine Creek.	Woods Run.	Ames.	Birmingham.
<i>Euphemus carbonarius</i> (Cox),	X	X			X	
<i>Patellostium montfortanum</i> (Norwood and Pratten),	X	X	X		X	
<i>Bellerophon pectarinatus</i> Conard,	X	X	X		X	
<i>B. stevensanus</i> McChesney,					X	
<i>Bucanopsis marcouana</i> (Gelnitz),		X				
<i>Dentalium meekianum</i> Gelnitz,		X				
<i>Soleniscus fusiformis</i> (Hall),	X					
<i>S. ventricosus</i> (Hall),					X	
<i>S. paludinaeformis</i> (Hall),					X	
<i>Sphaerodoma primogenia</i> (Conrad),		X				
<i>S. texana</i> (Shumard),					X	
<i>Loxonema scitulum</i> Meek and Worthen,	X					
<i>L. plicatum</i> Whitfield,					X	
<i>Strophostylus remex</i> (White),	X					
<i>Anomphalus rotulus</i> Meek and Worthen,	X					
<i>Porcellia peoriensis</i> Worthen,	X					
<i>Glaphurochiton carboniferous</i> (Stevens),			X		X	
<i>G. simplex</i> Raymond,	X					
<i>Orthoceras rushense</i> McChesney,		X	X		X	
<i>O. lasallense</i> Worthen,			X			
<i>Endobolus missouriense</i> (Swallow),	X					
<i>Metacoceras sangamonense</i> (Meek and Worthen),	X					
<i>Domatoceras highlandense</i> (Worthen),	X					
<i>Cyrtoceras curtum</i> Meek and Worthen,		X				
<i>Tennocheilus crassus</i> Hyatt,		X	X		X	
<i>T. wingslowi</i> Meek and Worthen,			X		X	
<i>Solenoccheilus collectus</i> Meek and Worthen,		X				
<i>Tainoceras occidentale</i> (Swallow),					X	X
<i>Goniattes lunatus</i> Miller and Gurley,		X	X			
<i>Griffithides scitula</i> Meek and Worthen,		X	X			
<i>Petalodus ohioensis</i> Safford,		X	X		X	
<i>Deltodus angularis</i> Newberry and Worthen,		X	X		X	
<i>Diplodus compressus</i> Newberry,				X		
<i>Fissodus inaequalis</i> (St. John and Worthen),					X	
<i>Cladodus occidentalis</i> Leidy,					X	
<i>Agassizodus variabilis</i> (Newberry and Worthen),					X	

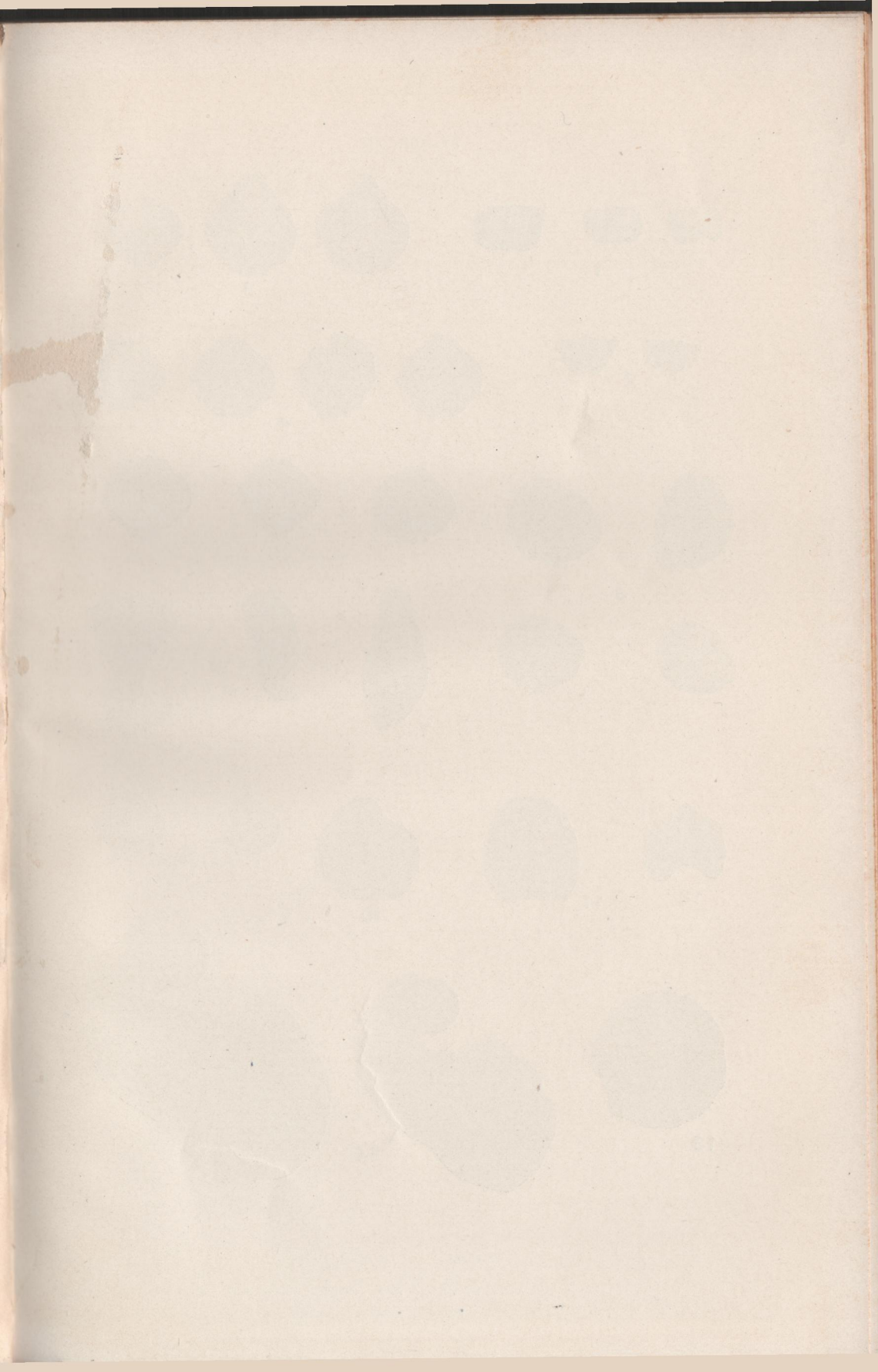
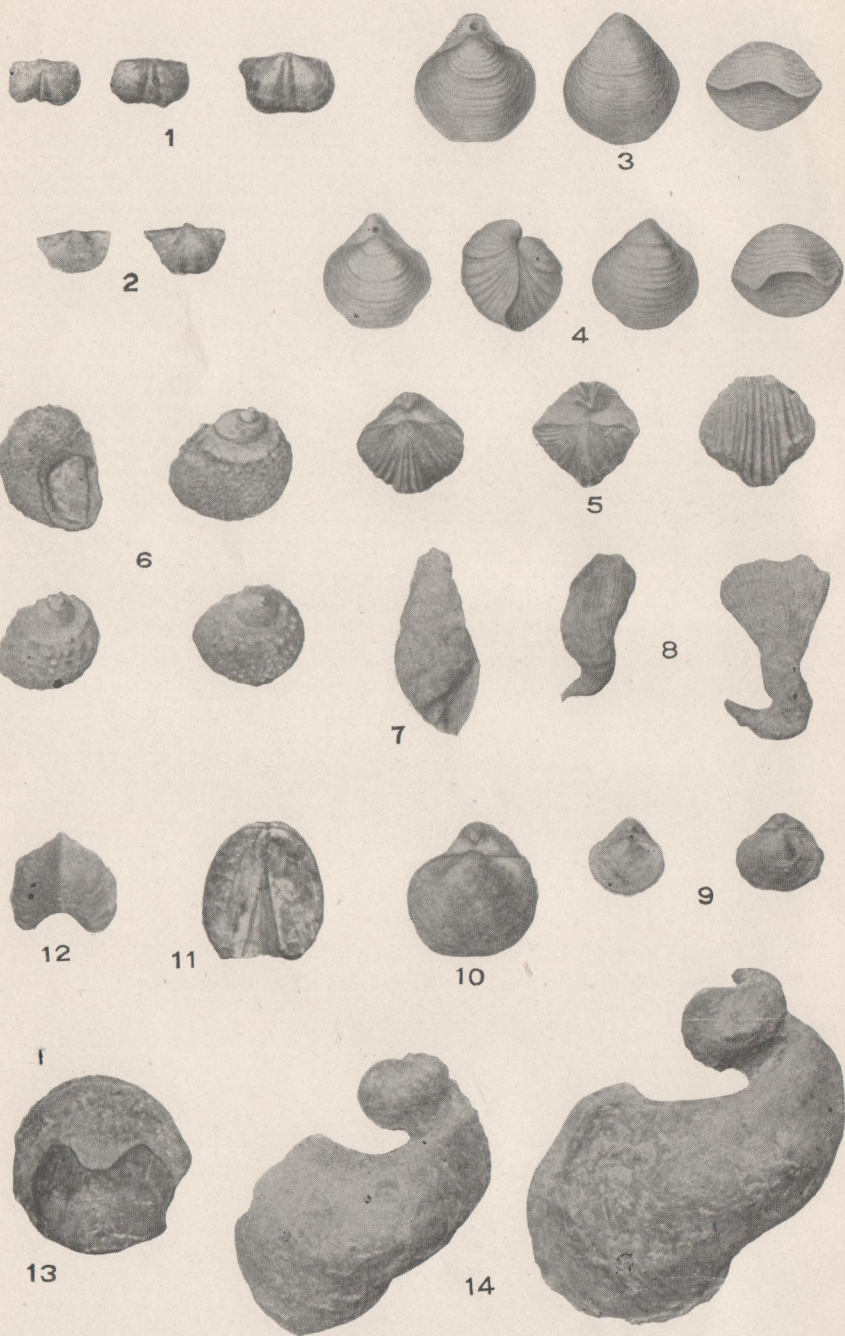


PLATE III.



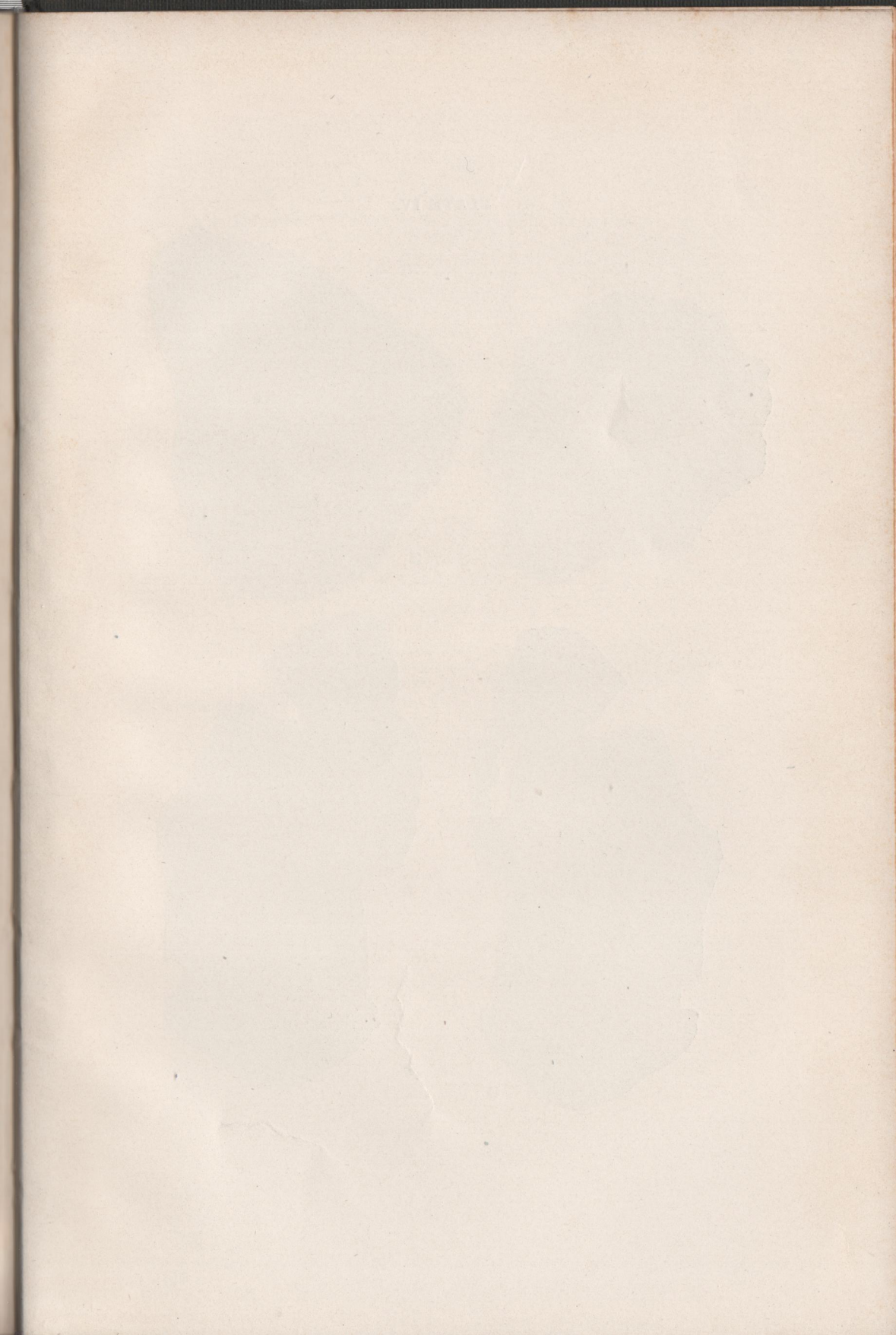
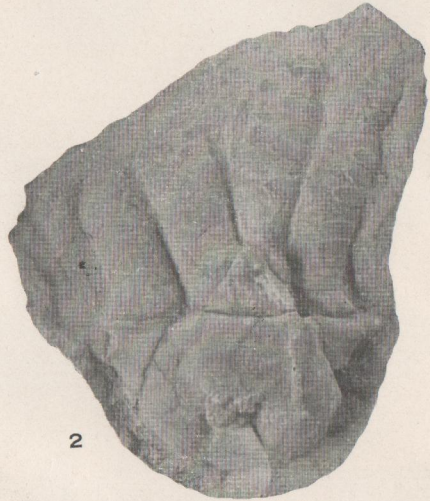


PLATE IV.



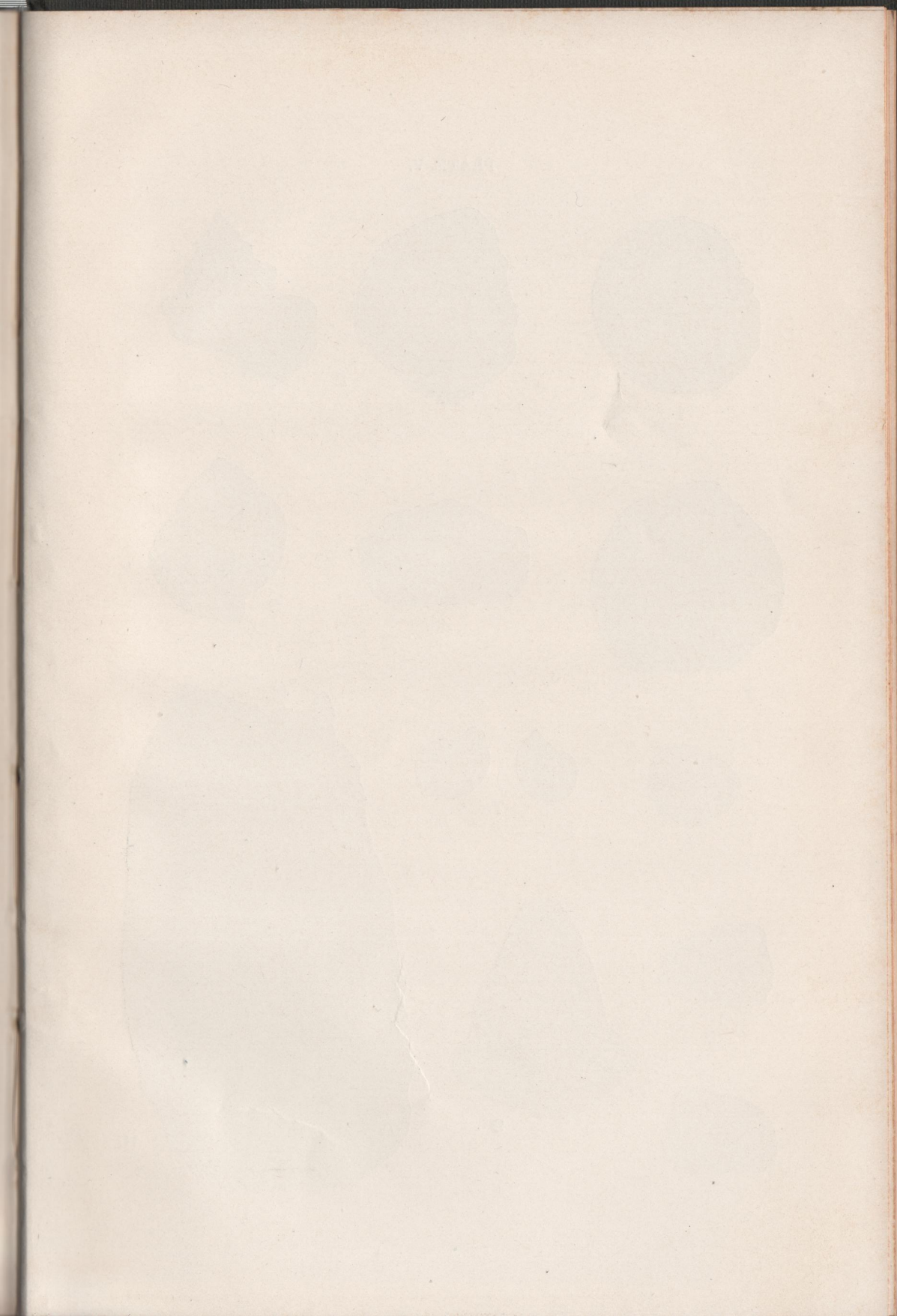


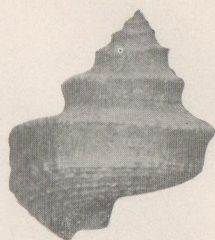
PLATE V.



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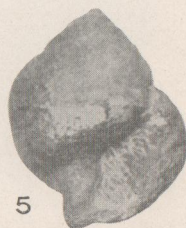
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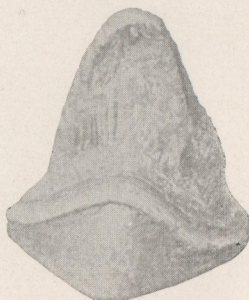
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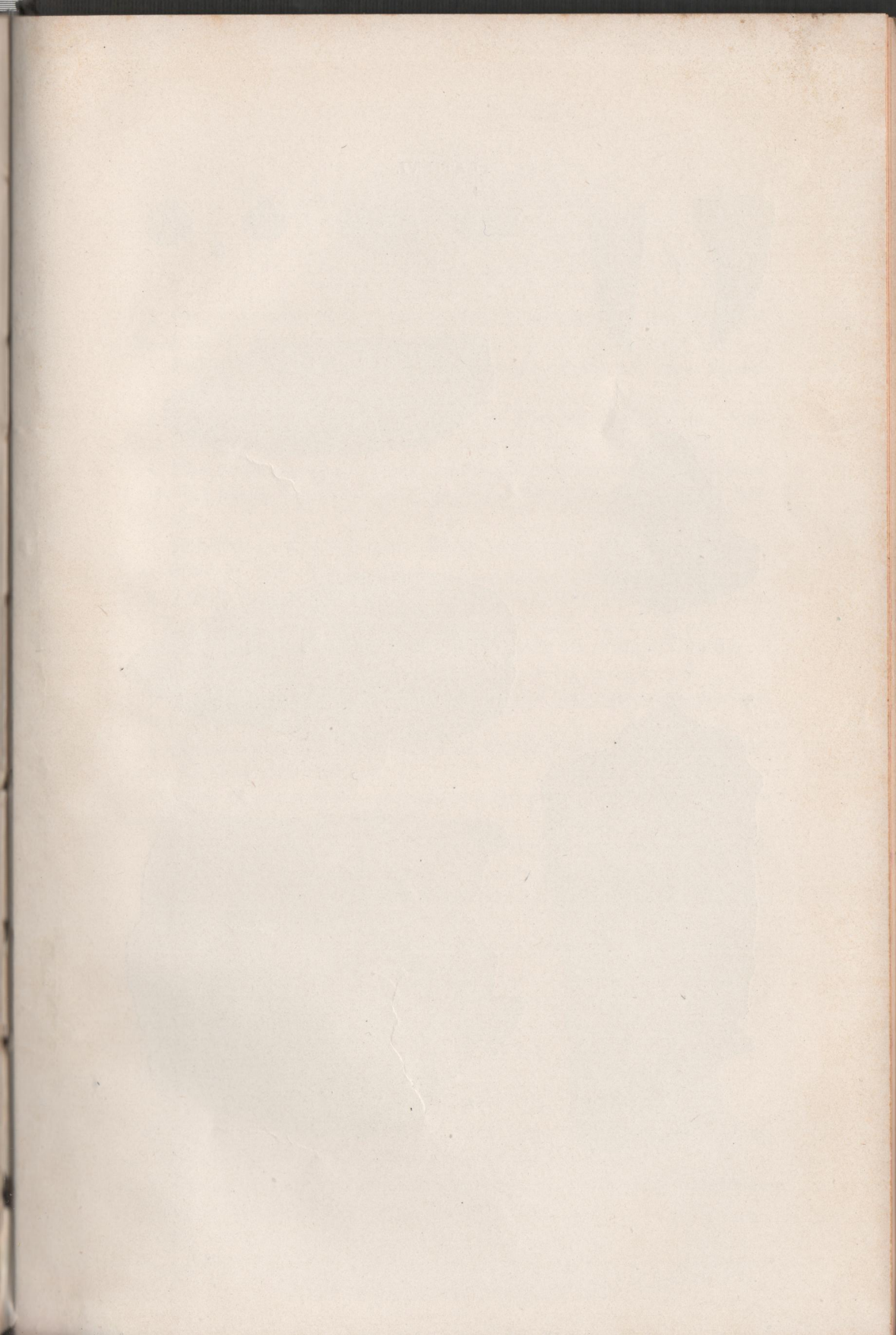


PLATE VI.

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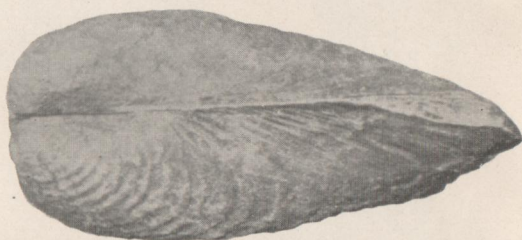
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EXPLANATION OF PLATES.

PLATE III.

1. *Chonetes mesolobus*. Three pedicle valves from the Vanport limestone at New Castle, Pa.
2. *Chonetes verneuili*. Two specimens from the same formation and locality.
3. *Composita girtyi*. Three views of a specimen from the Vanport limestone at New Castle, Pa. One-half larger than natural size.
4. The same species. Four views of a more robust specimen from the same formation and locality. One-half larger than natural size.
5. *Spirifer rockymontanus*. Three specimens from the Vanport limestone at New Castle, Pa.
6. *Trachydomia wheeleri*. Four specimens from the Vanport limestone at Rochester, Pa.
7. *Soleniscus fusiformis*. A specimen from the Vanport limestone at New Castle, Pa.
8. *Cyathaxonia distorta*. Two specimens from the same horizon and locality as the last.
9. *Squamularia perplexa*. Two specimens from the Vanport limestone at New Castle, Pa.
10. The same species. An unusually large specimen from the same locality as the last.
11. *Glaphurochiton simplex*. A tail-valve, seen from the inside. From the Vanport limestone at New Castle, Pa. Holotype.
12. The same species. One of the middle valves. From the same formation and locality. Paratype.
13. *Naticopsis torta*. An operculum from the Vanport limestone at New Castle, Pa.
14. The same species. Two specimens from the same horizon and locality as the preceding.

PLATE IV.

1. *Septopora biserialis*. A specimen from the Vanport limestone at New Castle, Pa. Three-fifths larger than natural size.
2. *Ceriacrinus craigi*. A specimen from the Brush Creek limestone at North Trafford, Pa. About natural size.

3. "*Cyrtoceras*" *curtum*. Exterior view of a specimen from the Brush Creek limestone at Donohoe, Pa. One-third less than natural size.
4. Interior view of the same specimen.

PLATE V.

1. *Pleurotomaria carbonaria*. A specimen from the Brush Creek limestone at Donohoe, Pa.
2. *Worthenia tabulata*. The characteristic fossil of the Brush Creek. Specimens from the Brush Creek at Donohoe, Pa.
3. *Productus nebraskensis*. A specimen from the Brush Creek limestone at North Trafford, Pa.
4. *Glaphurochiton carbonarius*. A median valve from the Pine Creek limestone at Stoops Ferry, Pa. Two and one-fourth times natural size.
5. *Sphærodoma primogenia*. A specimen from the Brush Creek limestone at Donohoe, Pa.
6. *Trepostira illinoisensis*. A specimen from the same horizon and locality as the last.
7. *Euomphalus catilloides*. Two specimens from the Brush Creek limestone at Donohoe, Pa.
8. *Astartella vera*. Two specimens from the same formation and locality as the last.
9. *Petalodus chioensis*. A large specimen from the Brush Creek limestone at Donohoe, Pa.
10. *Ceriocrinus craigi*. A specimen from the Brush Creek limestone at North Trafford, Pa. Somewhat larger than natural size.

PLATE VI.

1. *Lophophyllum profundum*. Two specimens from the Ames limestone at the Brilliant Cut-off, Pittsburg, Pa.
2. *Chonetes granulifer*. Two specimens from the Ames limestone at the Brilliant Cut-off, Pittsburg, Pa.
3. *Pugnax utah*. Two specimens from the Ames limestone at the Brilliant Cut-off, Pittsburg, Pa.
4. *Petalodus ohioensis*. A specimen from the Ames limestone at City Farm, opposite Homestead, Pa.
5. *Allorisma subcuneatum*. A specimen from the top of the Birmingham shales at Kenneywood Park, near Duquesne, Pa.
6. The same species. Another specimen from the same locality.
7. *Tainoceras occidentalis*. Ventral view of a specimen from the Ames limestone near Pitcairn, Pa. Collected by the Rev. P. E. Nordgren.
8. *Derbya robusta*. Specimen from the Ames limestone at Glenwood, Pa.

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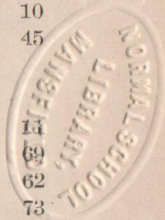
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